INTER AVIA

Review of World Aviation

In this Issue:

BRITISH AERONAUTICS IN 1948
S.B.A.C. DISPLAY AT FARNBOROUGH

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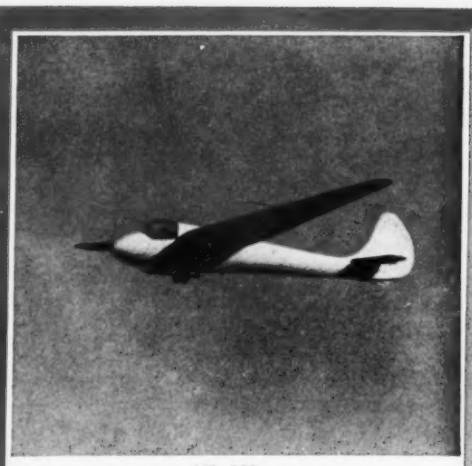
Dr. E. Saenger : Jet Reaction Flight — Nuclear Energy for Aircraft Propulsion
Rhein-Main Terminal — XR-11 "Rotor-Craft"
P. A. A. Fights for U. S. Domestic Routes
Soaring at Samedan

VOLUME III No 9 SEPTEMBER, 1948

Some French Aircraft Types now in Production

C. 800 GLIDER
Two-seater trainer



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High-performance sailplane

SIPA 90
Two-seater training and touring aircraft

NORD 1200 "NORECRIN"
Three-seater personal aeroplane

SUC 10 "COURLIS"
Taxi or personal aircraft

MORANE-SAULNIER 472
Two-seater fighter trainer

NC 702
Eight-passenger transport aeroplane

SO 30 R
Modern 30-passenger airliner

LANGUEDOC 161
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LATÉCOÈRE 631
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INTERAVIA

Review of World Aviation

OFFICIAL ORGAN OF THE FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE (F. A. I.)

Volume III — September, 1948 — No. 9

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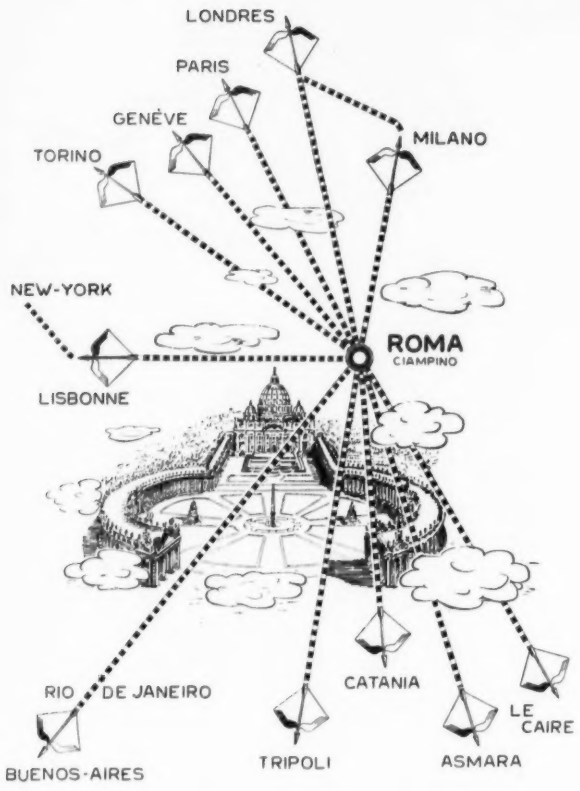

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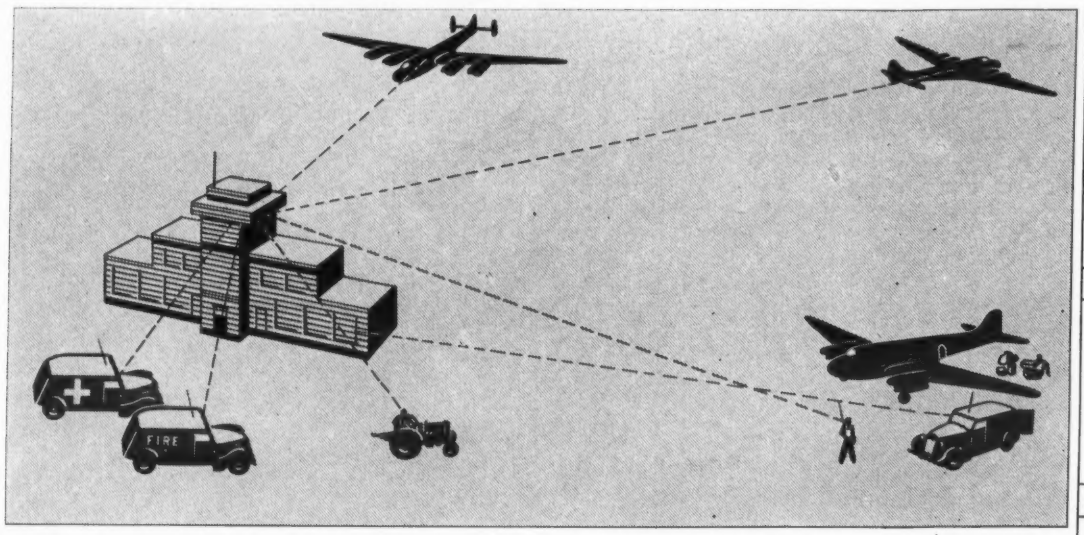
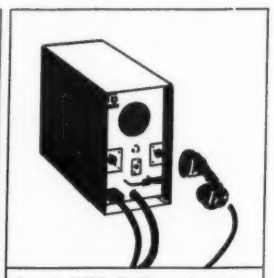
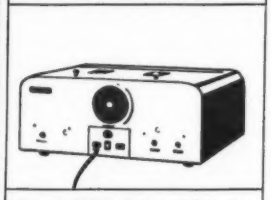
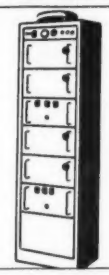




2 watt VHF Radio equipment



10 watt VHF Radio equipment



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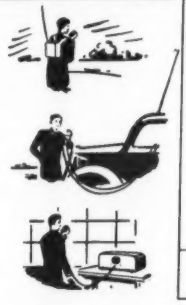
See these and other Marconi exhibits on Stand No. 7 East Exhibition Hall SBAC Exhibition and Flying Display, R. A. F. Aerodrome, Farnborough, 7th-12th September, 1948.



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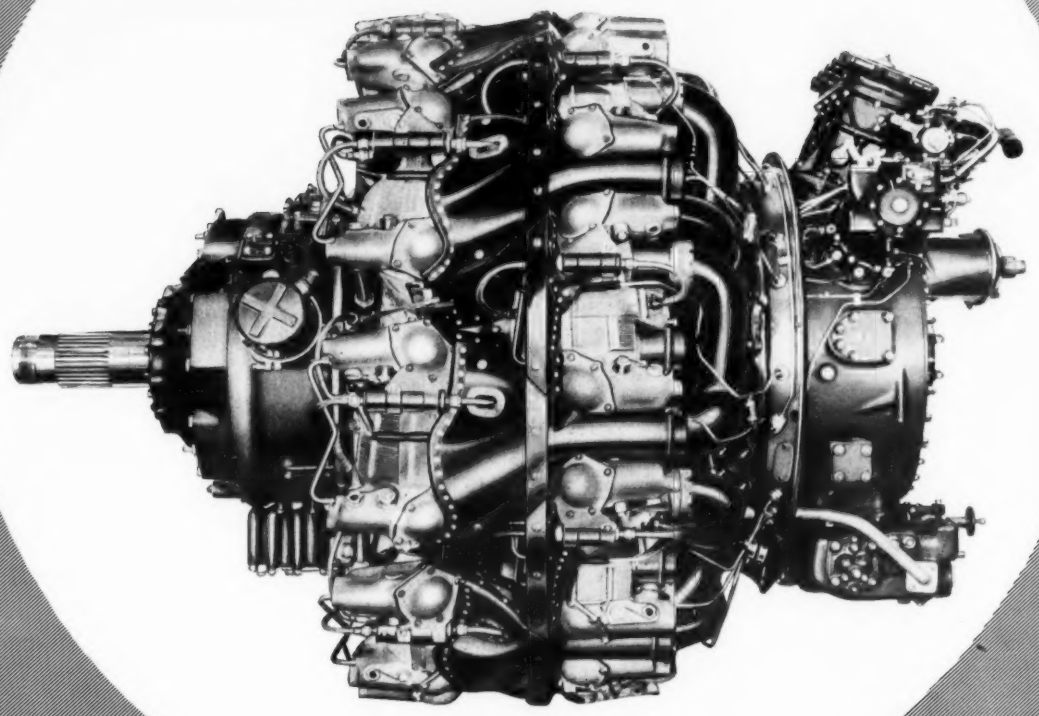

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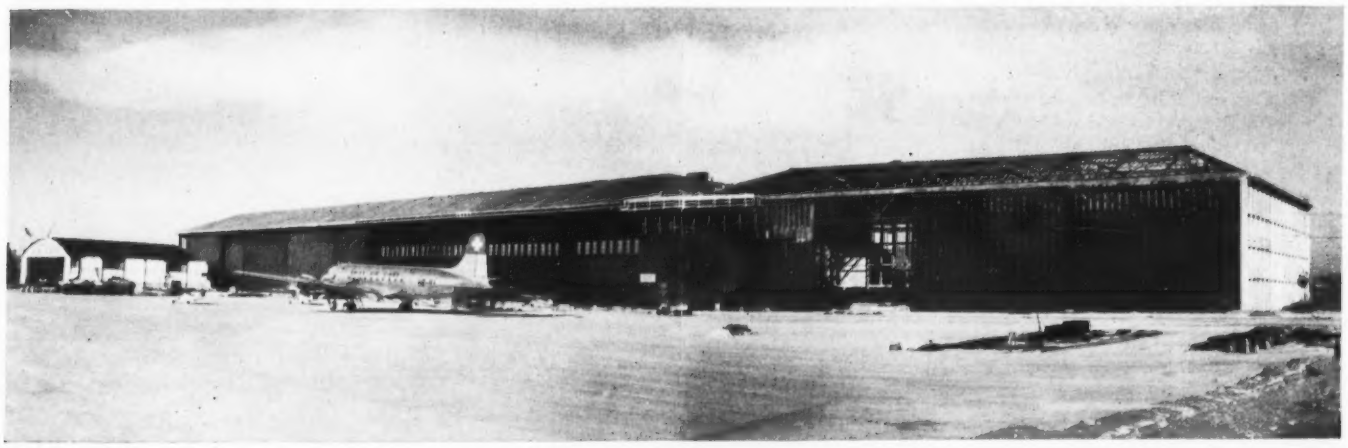

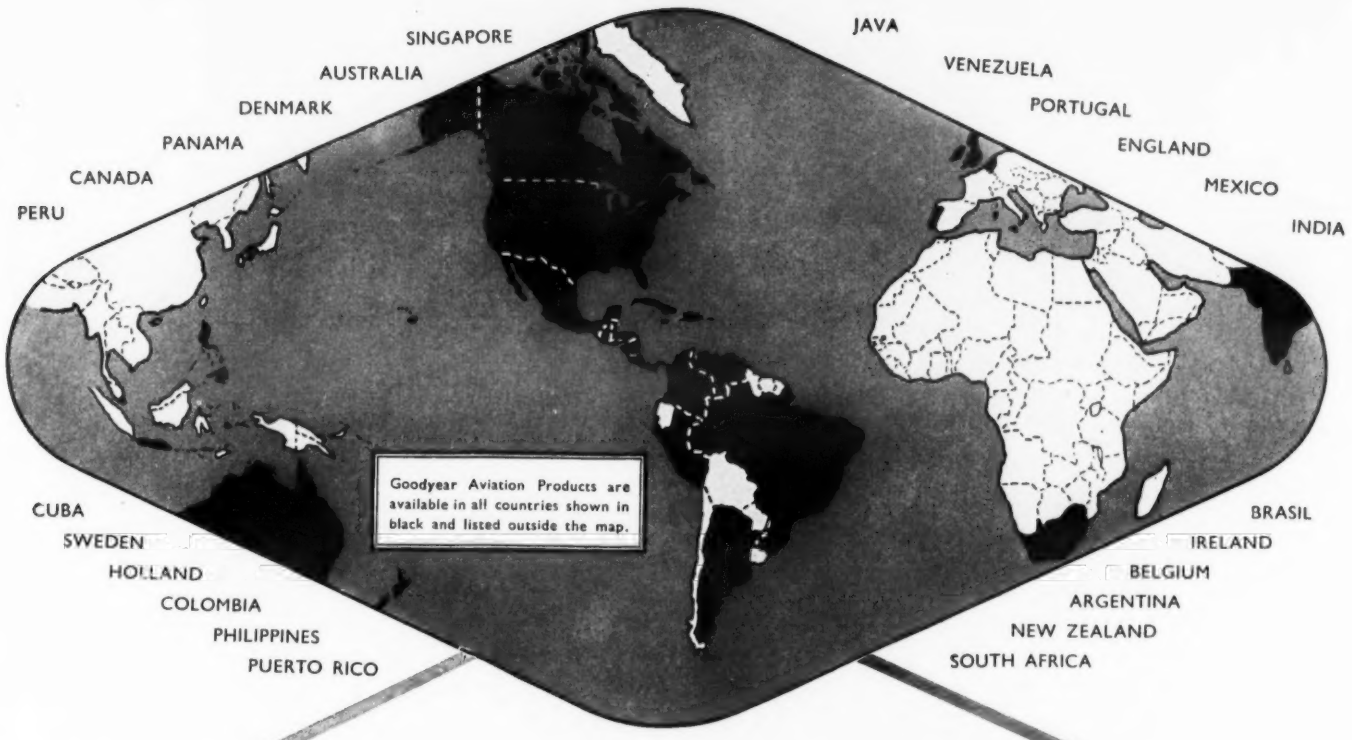

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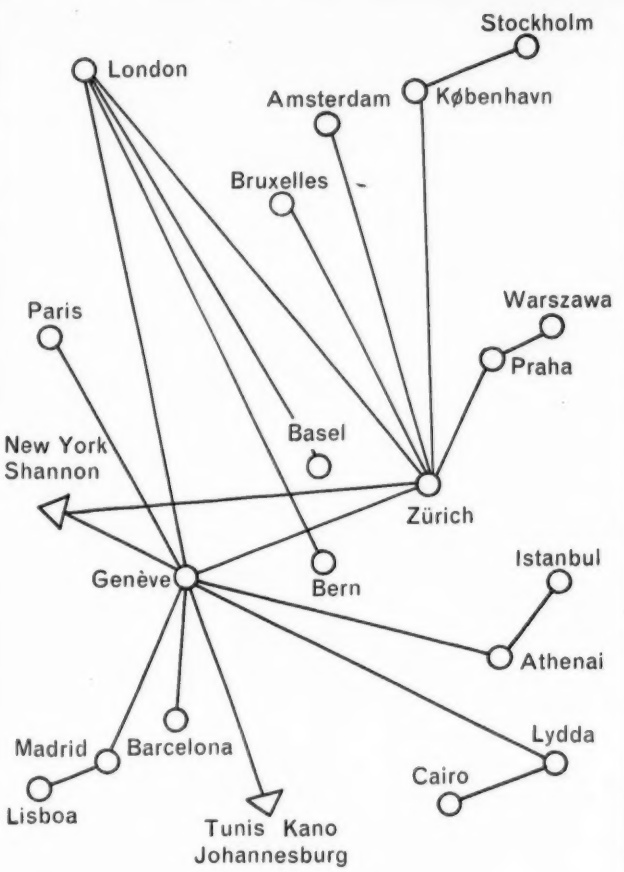

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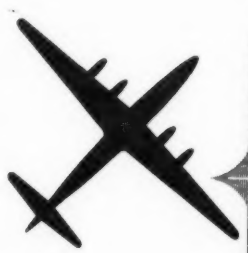

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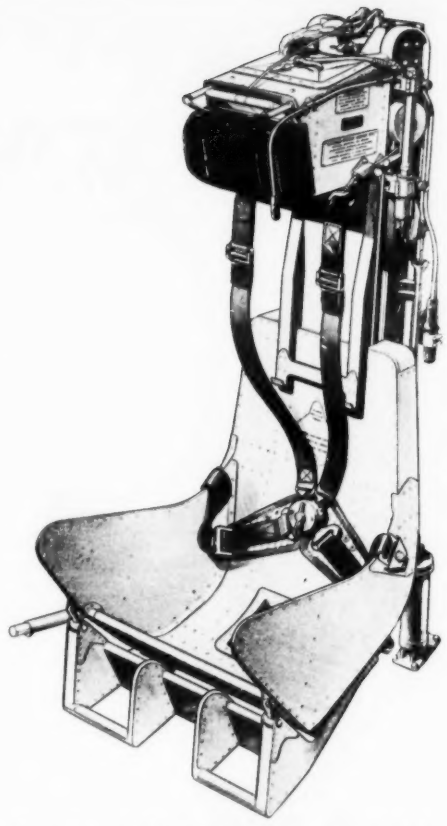
Date	*Place*	*Parachutist*
24th. July, 1946.	Chalgrove, Oxon.	B. I. Lynch, B. E. M.
11th. August, 1947.	Chalgrove, Oxon.	B. I. Lynch, B. E. M.
12th. August, 1947.	Chalgrove, Oxon.	P. Page.
14th. August, 1947.	Chalgrove, Oxon.	P. Page.
28th. February, 1948.	Chalgrove, Oxon.	Sous-lieutenant R. Cartier, Croix de Guerre, Chief Parachutist, Centre d'Essais en Vol, Bretigny, France.
25th. May, 1948	Central Fighter Establishment, R. A. F. West Raynham.	B. I. Lynch, B. E. M.
9th. June, 1948.	Centre d'Essais en Vol, Bretigny France.	Sous-lieutenant R. Cartier, Croix de Guerre.
10th. July, 1948.	Gatwick Air Display.	B. I. Lynch, B. E. M.
17th. July, 1948.	Central Fighter Establishment, R. A. F. West Raynham.	B. I. Lynch, B. E. M.

On 29th. August 1947, B. I. Lynch of the Martin-Baker Aircraft Company, was shot out of a Meteor travelling at 505 m.p.h., thus setting up a world's record. He landed with perfect safety.



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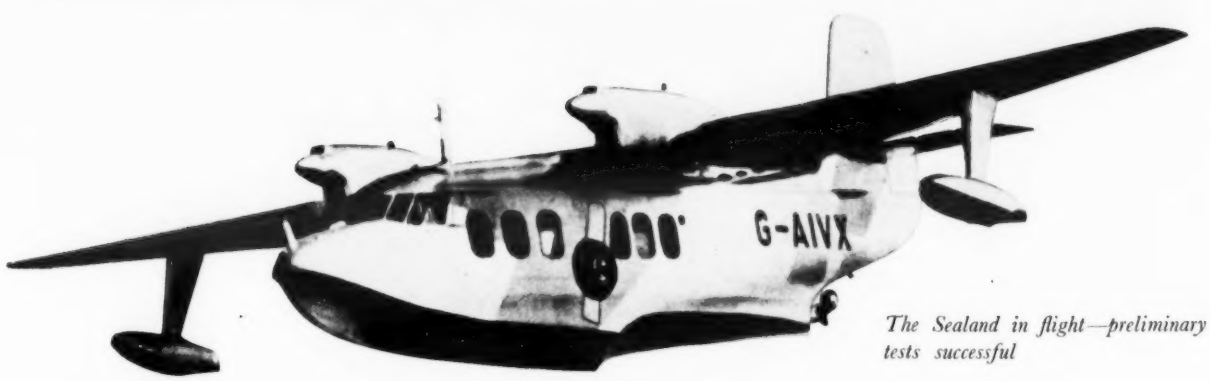


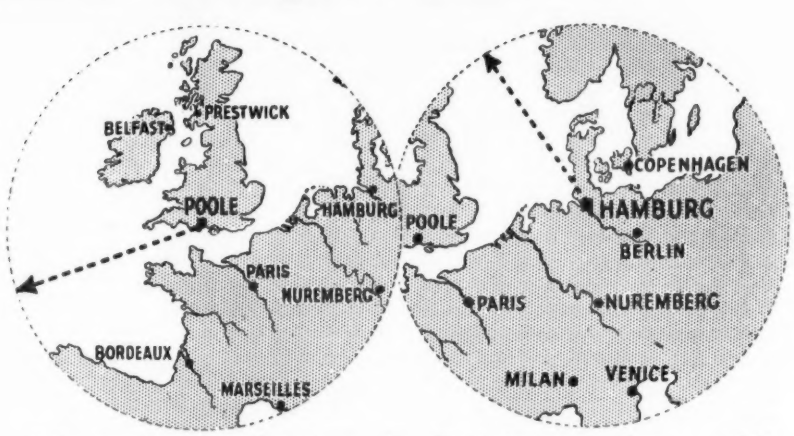
The Sealand in flight—preliminary tests successful

The Sealand steps out...

Successful flight trials

On January 22nd, the prototype Short Sealand made its first water take-off at Belfast after a series of engine runs ashore and afloat.

The preliminary flying tests were so satisfactory, that it has been decided to go forward to complete fitting-out without further tests being necessary.



Sealand maximum range-circle of 900 miles. The Sealand operates from any airfield, or from 776 yards of water.

Good news . . .

Good news for all who have sent in enquiries about the Sealand is that the first delivery is expected to be made during the Summer.

The Sealand is the ideal all-purpose amphibian, being available for such widely varying purposes as executives' communications craft, an airborne office or showroom, a freighter, for ambulance work, feeder lines and charter services. The payload is 1,400 lb. (or 7 passengers and luggage), with petrol consumption of better than 6 miles to the gallon, with a range of approximately 300 statute miles fully loaded.

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Chief Pilot

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O.B.E., *of* D.N.L.

ESCAPING from Norway in 1940 via Sweden, Russia, Turkey, Iraq, India and South Africa to Canada, Captain Strandrud spent some months there training pilots.

He came to England in 1941 and spent three years flying between Stockholm and Scotland with secret agents, political refugees from Norway, and government despatches. For belly-landing a Mosquito without harm to the V.I.P. in the bomb compartment, and for delivering the passenger, in another aircraft, on time in Stockholm, Strandrud was awarded the O.B.E. (Civil).

One of the most experienced and best pilots in Norway, Captain Strandrud is delighted with D.N.L.'s choice of Short Sandringhams for the Norwegian routes.

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Scandia

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Marginal Notes

27th July, 1948

The S.B.A.C. Display in Farnborough and the Mongrel in the Camp of the Thoroughbreds

Last year, guests invited by the Society of British Aircraft Constructors to attend the S.B.A.C. Display, met from September 9th to 12th at the Handley Page airfield, Radlett. This year, guests will meet between September 7th and 12th, thus during two additional days, at the airfield adjoining the Royal Aircraft Establishment in Farnborough. On the surface, the picture will probably be much the same as last year, even though—in view of the bad weather situation in some areas—there might not be as many Russian, Bulgarian, Czechoslovak and other uniforms from the eastern parts of Europe as in previous years.

However, there is no reason to doubt that this year's Display will continue to be a success. The S.B.A.C. knows its stuff and is thoroughly versed in the art of staging such events. If anybody wishes to see the best among turbo-jets and propeller-turbines, a number of good piston engines, impressive fighter prototypes, high-quality accessories and components, then Farnborough is where to find them.

Waiting for the Display to start brings back memories.

Last year at Radlett, a Canadair DC-4M four-engined airliner tried to take its place in the ranks of Britain's newest products. Since Canada belongs to the Commonwealth, the DC-4M considered itself to be one of the family—owing to the letter "M," meaning it was fitted with "Merlin" engines manufactured by the firm of Rolls-Royce Ltd. It also had other, definite reasons for wanting to be present. But it was sorely mistaken. The high-ups of the S.B.A.C., the top men in the British aircraft industry, did not consider the DC-4M's lineage to be sufficiently pure for it to mingle with the British thoroughbreds.

As if the men of the aircraft industry had the right to take decisions today ! The fate of the DC-4M might be compared with that of the former non-Aryan German Secretary of State for Air, Field Marshal Erhard Milch. Goering declared at the time : "I'll decide on who is Aryan and who isn't."—And today ? Which is a British aircraft and which is not, is a matter for the ruler of Britain's finances, Sir Stafford Cripps, to decide. Please don't think we're pulling your leg. This is absolutely true. And as far as we can see, Sir Stafford might just as easily have given priority to a Siamese aircraft.

In reality, meanwhile, the affair is of some importance. With it are concerned the British Parliament, press and aviation circles, as well as Canadians and Americans. Besides this, it is slightly connected with Farnborough.

For there is no end to the surprises which can arise in connection with the British aircraft industry . . .

The April, 1946, issue of our magazine bore tribute, in words and pictures, to a big airliner developed in Manchester by A. V. Roe & Co., Ltd., which had the proud and engaging name of "Tudor II." Our art editor was enthusiastic about the pictures and, in justice to this aircraft's family tree, lovingly presented the title in Gothic characters. Our trouble has not been rewarded, for we—in our own smaller way—mourn together with A. V. Roe & Co., their Hawker-Siddeley parent concern, the British aircraft industry in general, British air transport circles, and the British taxpayer. We, too, carried a wreath to the grave of the "Tudor II." This aircraft has been cast aside—and not even gently ! Forty-nine Avro "Tudor II" airliners, built for and refused by B.O.A.C., are looking for customers . . .

There are a lot of odd things in life, and among them is the fact that airline companies flying to all points of the compass—even though this is a costly undertaking in the case of the British airline corporations —have to possess aircraft. After a while, it dawned upon Sir Stafford Cripps that he would have to take this into account. For the British aircraft industry will not be able to deliver big airliners in quantity before about 1955. Thus the three national airline corporations were faced with the choice of either telling their flying personnel to turn to something like coal-mining for the next six years, or purchasing airliners from foreign countries.

Candidate No. I was the American Lockheed 749 "Constellation," of which B.O.A.C. has already acquired eleven units—some against good dollars, the others through a deal with the Irish government—and would have liked to buy more. But this was a dollar question, and Sir Stafford is notoriously fond of dollars... securely locked up in his counting house. So there could be no further "Constellations."

Candidate No. II was a mongrel, the Canadair DC-4M—a cross between the Douglas DC-4, the DC-6, and other elements, embodying English engines, American invention, and Canadian workmanship. In a way, it was the apple of the eye of Sir Stafford's Canadian colleague, Minister of Trade and Commerce Clarence D. Howe, who, as a wartime Minister of Reconstruction and Supply, had a hand in the establishment of Canadair Ltd. in 1944, and in the development of the DC-4M. To cut matters short, these two financial experts came to an agreement. B.O.A.C. will get airliners, and good ones at that. Their air fleet breaks all records as regards numbers, and they can really fly now. The deal went through to the tune of fourteen million Canadian dollars.

(Quite beside the point, what's your opinion of the Marshall plan ?)

Meanwhile, the presence of the Canadair DC-4M casts a slight shadow over Farnborough. It awakens the caricaturist's instinct : a weeping "Tudor II" standing in a far corner, and a Canadair DC-4M, which failed to make the society grade last year, grinning brazenly in the front row. Imagine the prototypes of future British airliners gleaming in the sun, and a small boy asking his father : "Are these the new aeroplanes for B.O.A.C. ?" With a heavy heart, the father has to answer : "Not yet, son. I don't know when they'll be ready for service." But the "Tudor II" is not the only costly experience made by the industry. Think of what Douglas, Lockheed, Boeing, Martin and Consolidated-Vultee have had to pour down the drain before they could put reliable multi-engined equipment into the air. Yes, the Americans, too, had to sacrifice plenty of millions of dollars—and if they don't know something about airliner production, then who does ?

The whole story reminds me of an English visitor I had a few days ago. He was a typical Englishman—six-foot-odd of straightforwardness and good manners. Logically, our conversation turned to aviation in his country. As far as engines, fighter aircraft, components and accessories, organisation—not to speak of the R.A.F.—were concerned, we were in perfect agreement. First class ! Then I miscued by asking about British civil aviation and B.O.A.C.'s plans. His answer was emphatic : there's nothing that can be done about those people ; they are completely enslaved by American ideas. Here I could not agree with him. I had to take sides with his countrymen.

For never—and the British would do well to remember this—has the British aircraft industry produced a big commercial transport of international repute ; neither before the War nor since he War. The industry recognised quite instinctively that its gifts lay in the field of aero-engines and fighter aircraft. And in these fields, the British are unbeatable and have been able to secure foreign markets for their wares.

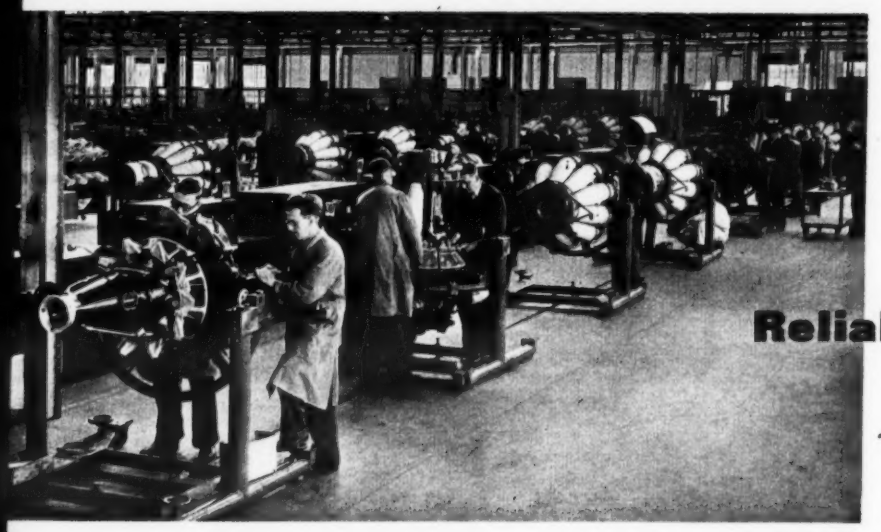
So when you go to Farnborough, open your eyes in amazement at the British fighter aircraft, which already once before, successfully defended the skies over Merrie Olde England. *E.E.H.*

British Aeronautics in 1948

Preview of the S.B.A.C. Display

This year, from September 7th to 12th, the Society of British Aircraft Constructors will stage its ninth Display. Its members' products will be exhibited on the ground and in the air, and experts from all airfaring countries will be invited. Whilst the 1946 and 1947 Displays were held at Radlett, this year's exhibition is to be at Farnborough, where there is more space and a better connection with London. And the prolongation of the Display to six days will give the public its first chance of viewing the demonstrations of the last day. On the other days, as in previous years, guests will have an opportunity of examining the aircraft on the ground, seeing them being put through their paces in the air, and viewing the industry's other products and new projects on the exhibition stands.

In the two preceding years, we published detailed articles on S.B.A.C. Displays after having visited them. This year, thanks to the ready co-operation of leading firms of the British aircraft industry, we were able to see the products in the factories, and are therefore able to give a preview of this year's S.B.A.C. Display. An account of the actual exhibition will be given in the November issue of this magazine.



Serial manufacture of "Derwent V" turbo-jets at Rolls-Royce Ltd., Derby.

Reliable Engines First — Then New Aircraft

British aero engines have enjoyed an excellent reputation for many decades. They embody centuries of metallurgical experience and the skill of generations of metal workers who have learned their trade in the home of mechanical industry. As one wanders through the aero-engine factories of Coventry, Derby, or Bristol, one does not see mechanised production lines or automatic machines, but the same furnaces, presses, lathes, drilling machines, control equipment and assembly benches as one would expect to see in any big machine factory. And the men handling the tools are not just quickly acquired helpers, but expert workers with skilled fingers and trained powers of observation.

However, high-quality manufacture alone is not sufficient to assure the future existence of this industry. Products have to move with new development and fulfil new demands. And it was the conservative British who, in the last few years, by treading new paths in the field of aircraft propulsion, reached the top of the ladder. Leaders as they are, they do not cease to set themselves new problems. Under the pressure of war, they developed the turbo-jet engine for high-speed fighters, perfecting it to a point where it could be considered operationally reliable. And it is the British who are now recommending propeller-turbines for moderate-speed aircraft. Many aircraft projects which they showed in model or blueprint form at the last two S.B.A.C. Displays, can now be realised as soon as propeller-turbines in the requisite power categories can be made available. At that time aero-engine manufacturers were announcing their propeller-turbines without any guarantee of short-term delivery. Thus the first question of the visitor to the 1948 S.B.A.C. Display will be : To what pitch has the development of these turbines progressed ? And it is for this reason that, contrary to usual practice, we are beginning this article with the engines.

Propeller-Turbines Ready for Production and Flight-Testing.

Visitors to Farnborough this year will be able to see, for the first time, aircraft taking-off and flying on no other power besides that furnished by propeller-turbines. To conclude from this, however, that these engines will straight away be used in civil aviation and the R.A.F., would be a little hasty. Still, many propeller-turbines have proved their reliability in long static test bench and flying test bench runs. On the one hand, therefore, they can now be built into new aircraft and in this way tested for their behaviour and particular characteristics. On the other hand, their construction is determined in every detail, so that there is no obstacle in the way of production. Hence we may speak of very marked progress since last year's S.B.A.C. Display at Radlett.

The first propeller-turbine of less than 1,500 H.P. to have reached the stage of production readiness, is the "*Mamba*" developed by *Armstrong Siddeley Motors, Ltd.*, of Coventry, which has already been described at length in a former issue of this magazine. Its development during the past year is highlighted by the following notes :

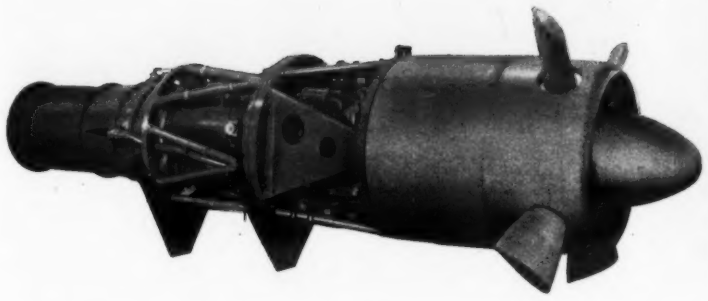
14th October, 1947—First test flight as fifth engine in the nose of a four-engined Avro "Lancaster" serving as flying test bench ;

21st February, 1948—Completion of Service Type Tests (civil and military) with 150 hours' running ;

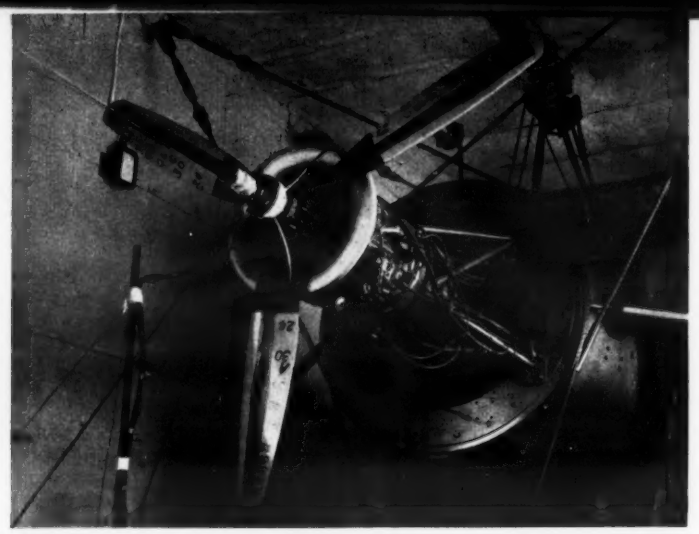
17th May and 12th June, 1948—First flights as sole power plant of Boulton Paul "Balliol I" and Avro "Athena I" training aircraft.

Armstrong Siddeley Motors have already put the "Mamba" into production ; the construction of all its components has been determined in detail, and time-saving devices for their manufacture and assembly, as well as up-to-date test benches for trial runs, are located at Ansty Aerodrome, near Coventry.

A second propeller-turbine of the same power class, the *Rolls-Royce "Dart,"* is also likely to be on show at Farnborough. Characteristics and performance data are to be released soon. It is at present being subjected to thorough tests in an Avro "Lancaster," and the first aircraft to be powered wholly with "Dart" turbines, the Vickers "Viscount," made its first flight on July 16th last.



Napier "Naiad" axial-flow propeller-turbine. Take-off power is 1,500 shaft horsepower plus 241 lbs. thrust.



Armstrong Siddeley "Mamba" axial-flow propeller-turbine on the test bench. Take-off power at 15,000 r.p.m. is 1,270 S.H.P. plus 384 lbs. thrust.

We finally come to the rather more powerful *"Naiad"* propeller-turbine, developed by *D. Napier & Son, Ltd.,* of Acton, London, which was on show at Radlett last year. Perhaps we shall learn more of it at this year's exhibition.

The title of this chapter also applies to the present stage of development of the only propeller-turbine of the 2,000-H.P. category, the *Bristol "Theseus."* This engine, of which the public has been hearing for over two years, passed its 150-hour test a long time ago. An Avro "Lincoln," with its two outboard engines replaced with "Theseus" units, was on show at the 1947 S.B.A.C. Display ; this installation has enabled valuable operational data to be collected—during such flights as one to Cairo and back, for instance.

Between June 19th and July 13th of this year, the "Theseus" was subjected to a series of test bench runs, uninterrupted by overhauls, totalling 500 hours, during which it was seen that output and service life largely met the requirements of civil air transportation : 33 "long-distance flights" each of 10 hours, and 34 "flights" each lasting five hours.

The Engine Division of The Bristol Aeroplane Co. Ltd., has devised ingenious processes for the manufacture of turbine components—among others the "lost wax process" for casting massive blade components from high-quality nickel alloys—so that everything is ready for serial production of the "Theseus." By the time these words are in print, the first four turbines for the Handley Page "Hermes V," the biggest airliner to be powered solely by turbines, will have been delivered.

A considerable advantage of the propeller-turbine, namely that it can be built to furnish greater outputs than the reciprocating engine, is not yet exploited in the case of these small and medium-size types. However, the British industry is building two high-power propeller-turbines, one being primarily for military use and the other more for civil purposes. Each competes with the most powerful piston engine in its field of application, and reveals its superiority as regards maximum shaft power at take-off.

Hardly to be regarded as a newcomer, the *Armstrong Siddeley "Python"* propeller-turbine, which was described in this magazine as long ago as June, 1946, delivers over 3,700 effective shaft horsepower in static operation and about 5,000 equivalent shaft horsepower (including exhaust thrust) at 300 m.p.h. flying speed. Though it has an axial compressor, the arrangement by which the air is made to flow from the rear to the front, and the disposal of the combustion chambers around the circumference, has kept the overall length within reasonable limits.

The 3,500-H.P. *Bristol "Proteus"* turbine, however, which is foreseen as power plant for a number of giant aircraft projects, will be shown for the first time to wide sections of the public at this year's S.B.A.C. Display. At the time of writing, no datum is available.

The question of whether preference should be given to turbine-propellers and turbo-jets with radial compressors, or to axial-flow designs (favoured in the U.S.A.), does not yet seem to have been answered conclusively in Great Britain. The aerodynamic and thermodynamic advantages of the axial-flow compressor are opposed by its more complicated and less rugged construction, and its greater sensitivity to the effects of icing and dust particles. Whereas the British turbo-jets, with exception of the Metrovick "Beryl," have radial compressors, the majority of propeller-turbines feature axial-flow layouts ; but the Rolls-Royce "Dart," which forms an exception to this rule, attracts just as much interest as its slenderer counterpart, the Armstrong Siddeley "Mamba."

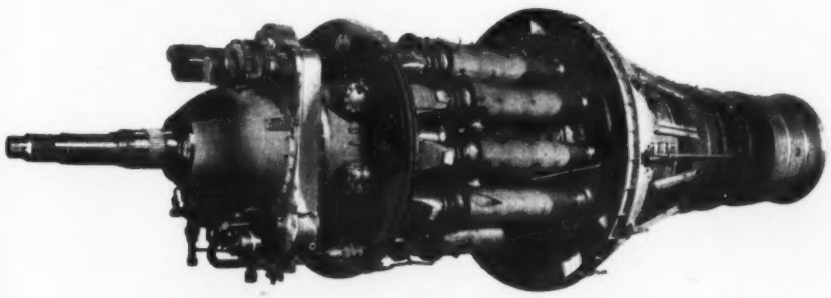
Turbo-jet Engines : Proven Types in Production.

Though the focal point of interest to visitors to this year's S.B.A.C. Display will probably be the propeller-turbines now ready for service, there should be no under-estimation of the perhaps less prominent accomplishments of those firms producing turbo-jet engines. It is they who carried the main burden of development work on aircraft gas turbines as a whole, before jet-propulsion for fast aircraft became an understood thing. The growing number of British jet aircraft in service, both in Britain and overseas, proves that these engines are well beyond the experimental and testing stages, although no great show of publicity was given to the completion of their acceptance trials. A good example is presented by the Rolls-Royce "Derwent V," which powers the Gloster "Meteor 4." The engine which stood up to the specified 500-hour test was a unit selected at random from the series ; main overhauls need only be carried out after every 200 hours, and several of these engines have already flown more than 360 hours.

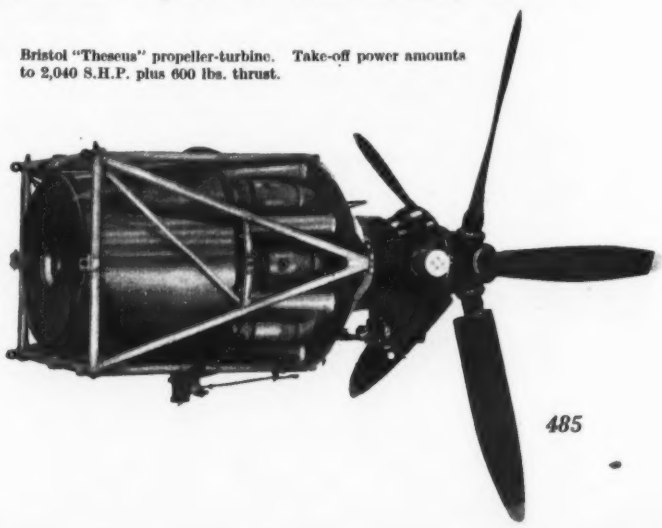
There will be no new turbo-jet engine on show this year at Farnborough, since what is being developed today in this domain, is shrouded in military secrecy. In any case, engines of higher output, in view of the present stage of airframe design and until the sonic barrier has been more thoroughly probed, can only be used for improving climbing performance.

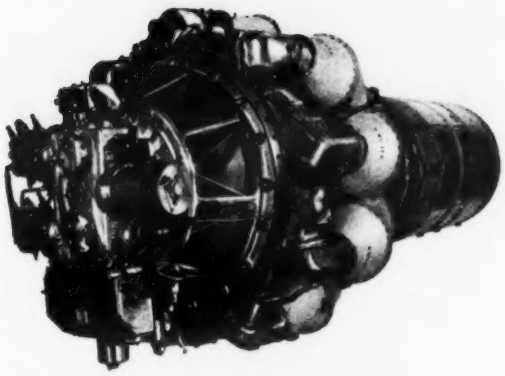
In the meantime, work is proceeding to improve the service reliability—which in

Armstrong Siddeley "Python" high-performance propeller-turbine. Take-off power is approximately 3,700 S.H.P. plus 1,150 lbs. thrust.

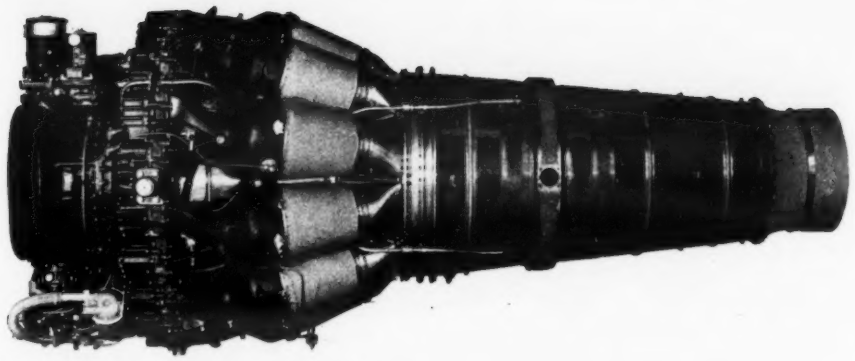


Bristol "Theseus" propeller-turbine. Take-off power amounts to 2,040 S.H.P. plus 600 lbs. thrust.

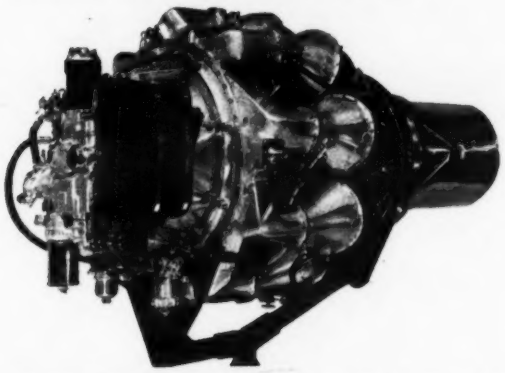




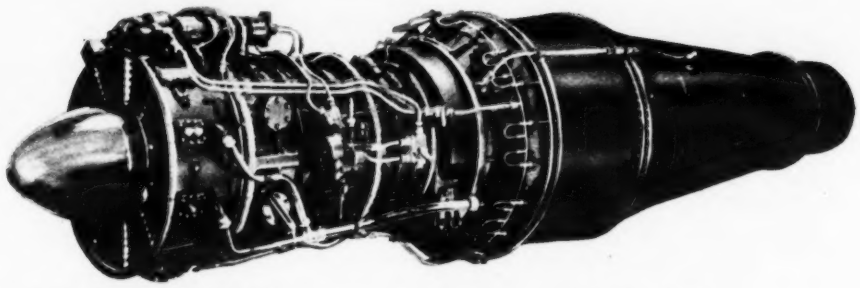
Rolls-Royce "Nene" turbo-jet: 5,000 lbs. static thrust.



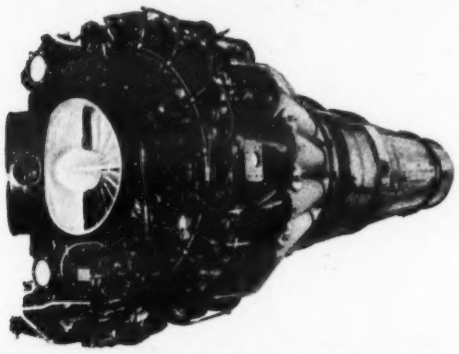
De Havilland "Ghost" turbo-jet: 5,000 lbs. static thrust.



Rolls-Royce "Derwent V" turbo-jet of 3,500 lbs. static thrust.



Metropolitan-Vickers F. 2/4 "Beryl" turbo-jet with axial-flow compressor: 3,850 lbs. static thrust.



De Havilland "Goblin" turbo-jet of 3,000-3,300 lbs. static thrust.

time will surely be followed by an increase in permissible thrust; proven types are being produced in larger numbers, and licence production outside the British Isles is being organised. The fruits of this costly development work are already perceptible.

Will the Americans, who have at their disposal more impressive means for research and development, take away the British lead in this field? It cannot be denied that U.S. firms are today building engines of the same thrust power; but the present British lead is based on high-quality products, and if the Americans have hitherto been able to learn from them, it may be that they will have something to show the British in the future.

And the Good Old Piston Engines.

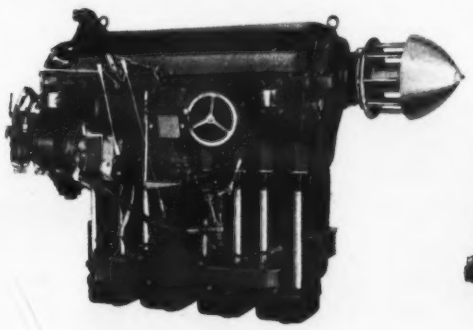
Throughout the world today, there is not a single civil airliner which does not fly on piston engines. And the British aero-engine industry is still producing more piston engines than turbo-jets and propeller-turbines. Those that will be on display at Farnborough will be the old, proven types, some being special versions, and others being completely detachable power units for certain new types of aircraft. To describe them in detail would be beyond the scope of this article, but the accompanying list, compiled according to power output, will at least show the strong and weak points of present-day British production. Below 375-H.P. take-off power, there is a well-spaced series of engines for private, training and short-range aircraft; four war-proven engines in the 1,300 to 2,850 H.P. bracket have been brought out in new versions adapted to the requirements of civil aviation; and finally, there are two big engines which have hitherto been used for military purposes only. But between 373 and 1,300 H.P. is a large gap, which must be particularly noticeable in the rotary-wing domain, and which is filled only by the Alvis "Leonides," in competition with older engines from war stocks of various countries.

Blackburn Aircraft Ltd. is the only firm to have supplied new constructions. These are the 185-H.P. four-cylinder *"Bombardier"* and the 300-H.P. six-cylinder *"Grenadier"* air-cooled inverted in-line engines, of which production is to begin in a few months' time. Both have direct fuel injection.

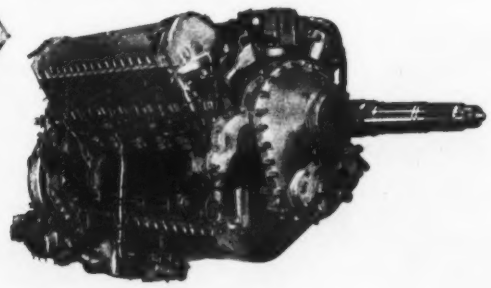
British Piston Aero-Engines, 1948

Manufacturer	Designation	No. of Cyl.	Cooled by	Take-off H.P.
Blackburn	Cirrus Minor	4	Air	90-100
Blackburn	Cirrus Major	4	Air	130-155
de Havilland	Gipsy Major 10	4	Air	145
de Havilland	Gipsy Major 50	4	Air	200
de Havilland	Gipsy Queen	6	Air	250-375
Alvis	Leonides	9	Air	505-530
Rolls-Royce	Merlin	12	Liquid	1,300-1,750
Bristol	Hercules	14	Air	1,700-2,030
Rolls-Royce	Griffon	12	Liquid	1,560-2,380
Bristol	Centaurus	18	Air	2,535-2,850
Napier	Sabre	24	Liquid	2,340-3,050
Rolls-Royce	Eagle	24	Liquid	3,550

A British in-line engine for light aircraft: Blackburn "Cirrus Major" of 155 H.P. The new Blackburn "Bombardier" with direct fuel injection will furnish 185 H.P.

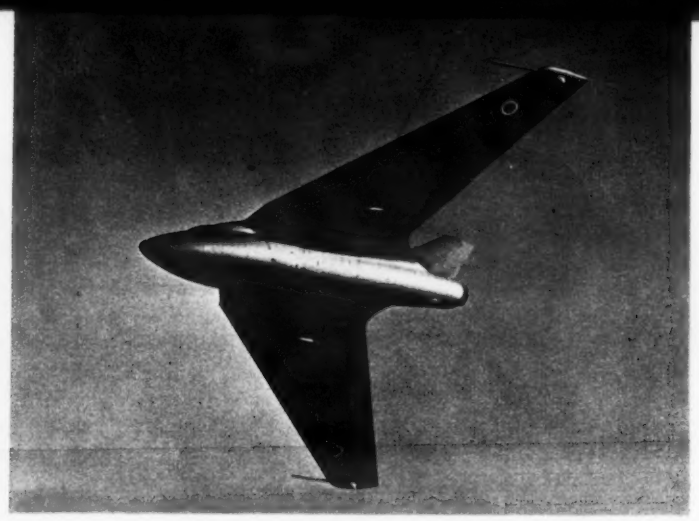


The newest Rolls-Royce engine, the "Griffon 57," delivers a take-off power of 2,350 H.P. with water-methanol injection. Driving contra-rotating propellers, it is designed primarily for long-distance flights at low altitude with small load. It has a single-stage supercharger.



High-power sleeve-valve aero-engines are a British speciality. This photo shows the Bristol "Centaurus" 18-cylinder twin-row radial, which is being improved to deliver 3,000 H.P.

The experimental Armstrong Whitworth A.W. 52 tailless mail aircraft, powered with two Rolls-Royce "Nenes." Span 90 ft., take-off weight 33,000 lbs., maximum speed 500 m.p.h. (up to 20,000 ft.); flying 330 m.p.h. at 36,000 ft., its range is 1,500 miles.



The single-seater de Havilland D.H. 108 "Swallow" experimental high-speed aircraft.

Experimental Types and Aircraft under Test

The leading position which Great Britain has reached and still maintains in engine design can form the point of departure for the future development of her aircraft. It has already taken on this rôle for jet fighters, which England is producing, flying and—as the only country in the world—exporting in large numbers. For, apart from its advance in jet design, the British industry was greatly helped by the fact that, during the entire War, it was able to concentrate on the development of fighter aircraft powered with piston engines, to which England owed her salvation during 1940.

Airliner construction presents a different picture, for England was compelled to relinquish her activities in this field during the war years. It means that twice as much work has now to be accomplished if the "new look" of the turbine aircraft is to find acceptance. On the one hand, the newly-arrived propeller-turbine has to be tested as regards installation, operational behaviour, maintenance, etc., in aircraft; on the other hand, the ground lost in transport aircraft construction has to be retrieved. The second problem does not only concern the aircraft firms—who, in the writer's opinion, are technically capable of tackling it—but equally as much the Government authorities; for it is the latter who, by assigning contracts on behalf of the state-owned airline corporations, determine the developmental goals, and by fixing the taxation levels, can either cripple or foster the initiative of private enterprise.

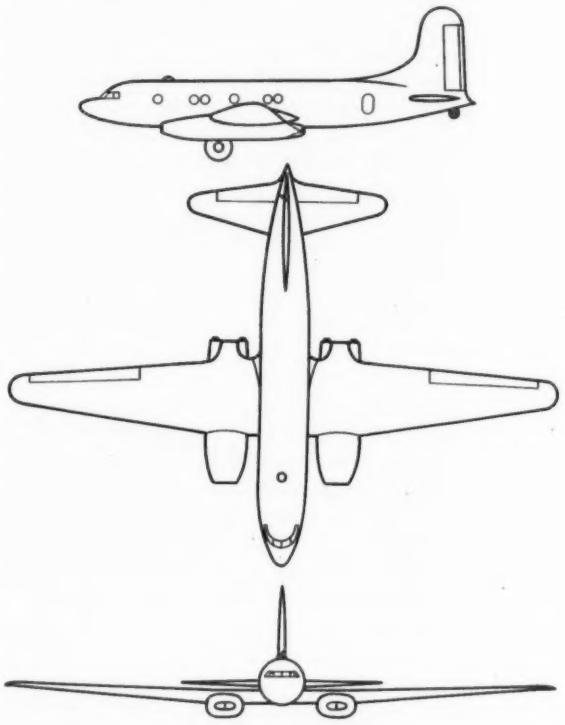
The aircraft which will be shown in flight or in model form at the coming S.B.A.C. Display, reveal a multitude of developmental threads which may ultimately be interwoven in the standard British airliners of 1951 and later.

Experimental Jet Aircraft.

One of these developmental threads leads past the turbine aircraft to the multi-engined jet aircraft. It would be bold to surmise that the first big British jet aircraft—U.S. types are already under trial—will be used for civil aviation purposes; but nothing will be heard about jet bombers at this peaceful display. Let us therefore return to the four experimental aircraft which are certain to appear at Farnborough, and which give us a glimpse of what the future holds in store.

The first is a special version of the well-known *Vickers V. C. 1. "Viking"* airliner, fitted with two *Rolls-Royce "Nene"* turbo-jets, which has enabled Vickers-Armstrongs, Ltd., of Weybridge, to make more extensive tests with jet engines than they could have done with small single-seater fighters. Since the aircraft has been specially reinforced and this power plant furnishes considerably more output than the normally-used piston engine, it can attain relatively high speeds. It is, furthermore, not excluded that it may be used for aerodynamic investigations, for instance with regard to the influence upon each other of the efflux jet stream and the tail assembly, or to obtain new data on the "Viking" at higher speeds.

A problem of extreme importance to the development of future jet-propelled airliners concerns the behaviour of aircraft and engines at great altitudes. For the first time, this problem can now be probed with the *"Tudor VIII"* version of the Avro "Tudor" airliner, which provides room for every imaginable



Model of the experimental Avro "Tudor VIII" airliner powered with four Rolls-Royce "Nene" turbo-jets each giving 5,000 lbs. static thrust. It features the same dimensions as the "Tudor IV."

The first airliner to fly on pure jet power was the Vickers "Viking" exceptionally fitted with two Rolls-Royce "Nene" units, which recently covered the London—Paris run in 34 minutes (not counting the formalities before taking-off and after landing).

measuring apparatus in its large pressurised cabin, and is powered with four *Rolls-Royce "Nene"* engines. The latter are grouped in pairs inside large nacelles, but have widely separated jet nozzles.

More unusual in appearance are the two units of the *Armstrong Whitworth A.W. 52* tailless two-seater, an aircraft which from the start was built for research purposes. One of these is powered with two Rolls-Royce "Nene" engines of 5,000 lbs. static thrust, and the other with two Rolls-Royce "Derwent" units of 3,500 lbs. They have double flaps fitted to the outer wings, whose rear halves serve as ailerons and, when extended in the same direction, as elevators. The front half of each flap, known as the "Corrector," is coupled hydraulically with the landing flaps, positioned at the wing centre section, and is extended upwards through a few degrees when the landing flaps are moved downwards. This means that even when the landing flaps are used, the centre of pressure is pinned down and the manoeuvrability retained. Rudders positioned at the wing tips are used for lateral control.

The wing of the A.W. 52 is of laminar profile, and its monocoque construction without spar gives the skin exceptional stiffness and very accurate maintenance of the laminar profile. Finally, the aerodynamic quality of the wing is further improved by the presence of slits half way across the chord, which enable the boundary layer to be sucked into the air intakes of the jet engines.

A review of the experimental jet aircraft which will be on show in Farnborough would be incomplete if no mention were made of another tailless type, the single-seater *de Havilland D.H. 108 "Swallow,"* of which the third version, demonstrated last year, established on April 12th an international record over a 100-kilometre closed circuit, averaging 974 k.p.h., with Squadron Leader John Derry at the controls. The "Swallow" is powered with a de Havilland "Goblin" and is known to be a research aircraft preceding the *de Havilland D.H. 106 "Comet,"* a high-speed trans-Atlantic airliner project which will be powered with four de Havilland "Ghost" turbo-jets. As this concerns a project to be realised in some years time, not much information has yet been released.

Airliners Powered with Propeller-Turbines.

At first thought it seems that it would be a simple matter to take a conventionally-powered airliner and merely replace its piston engine with propeller-turbines. However, the main problem concerning multi-engined turbine-powered aircraft is not so much one of operational reliability as one of the propeller-turbine itself.

In reality, the utilisation of propeller-turbines—especially under the new ICAO regulations—is rather more a call for a thorough revision of the entire principle of aircraft design. If a propeller-turbine has to run more or less economically in cruising flight, it must turn at about 95 per cent. of maximum r.p.m., consequently delivering 75 per cent. of its maximum power, whilst a reciprocating engine can be throttled down to 50 per cent. take-off power without necessity for increasing the specific consumption. The power which the propeller-turbine can give during the take-off in emergency is, therefore, only about a third greater than its economic cruising power, whereas this can be brought to double the cruising power in piston engines. The ICAO regulations, specifying that completion of a take-off must be possible even in the event of the failure of one engine, can therefore only be fulfilled by turbine-powered aircraft if a smaller reserve of take-off power is necessary, and if this can also be better exploited in cruising flight than in the case of a piston-engined aircraft. The majority of aircraft powered with propeller-turbines will therefore be equipped with a greater number of engines and will have to cruise at high speeds. They will have pressurised cabins for operating at greater altitudes, but will temporarily be restricted to short and medium-distance routes in view of their high fuel consumption.

We could therefore summarise by saying that turbine-powered airliners of the next few years will either have to be developed from scratch, or derived from extremely modern medium-range transport aircraft ; and even if of only medium weight, they will have to be four-engined. To convert obsolescent, low-speed types without pressurisation, even only experimentally, into turbine-powered aircraft, would not be advisable.

Indeed, the British industry seems to have shunned all temptation of this nature. The types which will be on show at Farnborough are not experimental aircraft, built for research in a new aeronautical field, but test aircraft which have been worked out in every detail, differing no more and no less from their future production versions than any conventional prototype differs from the final product. Unfortunately, only one, or at the best two, of these new turbine-powered airliners will be demonstrated. The others are still under construction ; but the majority of them will be completed before the end of the year, so that the scale models of them will nevertheless be interesting.

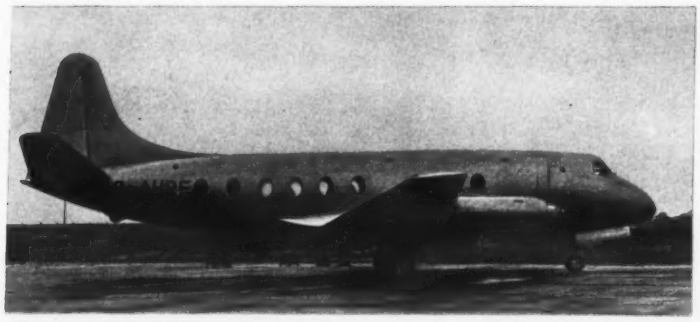
Two of these aircraft fulfil the type IIB requirements of the Brabazon Programme, the plan elaborated at the end of the War to determine the future development of British transport aircraft. They are destined for operation over the routes from England to the Continent, in place of the Vickers "Viking" used at present, and are to accommodate 30 to 35 passengers. One of them is a product of *Vickers-Armstrongs, Ltd.*, and bears the designation *V. C. 2. "Viking."* Already completed up to its installation for thirty-two passengers, it made its first flight on July 16th last and is to be demonstrated in the air at Farnborough. Its counterpart, the *A.W. 55 "Apollo"* developed by *Sir W. G. Armstrong Whitworth Aircraft, Ltd.*, of Baginton, Coventry, is still under construction and is not expected to take the air before the end of this year.

Both types are powered with four propeller-turbines, the "Viscount" with Rolls-Royce "Darts" of over 1,000 H.P., and the "Apollo" with Armstrong-Siddeley "Mambas" of 1,020 H.P. take-off shaft power, plus 320 lbs. static thrust. They are modern low-wing monoplanes of reinforced monocoque construction, with tricycle undercarriages, pressurised cabins, internal de-icing, and so forth. Their main dimensions, weights and design performance data are contained in the accompanying table.

Thanks to the distribution of power among four relatively small turbines, small propeller diameters have resulted—ten feet in the case of the "Apollo"—so that the undercarriage legs are short and the good supply of control openings in the wing underside as well as a part of the accessories built on to the engine are within easy reach from the ground for both aircraft. By releasing very few joints, each engine can be dismantled as an entire unit in not more than half an hour.

In the Vickers "Viscount," the exhaust gases are used to only a small extent for additional thrust, but are made good use of for thermal de-icing of the wing leading edge. They are ejected underneath the wing ; in the case of the two inboard turbines, from the side of the cowling away from the fuselage, and from the cowling's lower side in the case of the two outboard turbines. As a result, the exhaust noise is kept well away from the passenger cabin. Hydraulic actuating devices

The Vickers "Viscount" airliner, powered with propeller-turbines, accommodates 32-36 passengers. Its test flights have already begun.



Four-Turbine Airliners for Medium Hauls

	Vickers V. C. 2 "Viscount" (4 R.-R. "Darts")	Armstrong-Whitworth A. W. 55 "Apollo" (4 A. A. "Mambas")
Span	89 ft. 0 in.	92 ft. 0 in.
Length	70 ft. 11 in.	74 ft. 6 in.
Height.....	26 ft. 3 in.	25 ft. 1 in.
Wing area	885 sq. ft.	986 sq. ft.
Empty weight ...	27,450 lbs.	23,319 sq. ft.
Disposable load . including payload	13,050 lbs. (36 passengers)	13,690 lbs. 7,500 lbs.
Normal take-off weight	40,500 lbs.	37,000 lbs. *
Landing weight .	39,000 lbs.	34,000 lbs.
Normal wing loading	45.75 lb./sq. ft.	37.5 lb./sq. ft.
Fuel supply.....	1,200 Imp. Galls.	680 Imp. Galls. *
Max. speed at 20,000 ft.....	331 m.p.h.	345 m.p.h.
Cruising speed at 20,000 ft.....	276 m.p.h.	276 m.p.h.
Rate of climb at sea-level	27.9 ft./sec.	35 ft./sec.
Same with one engine cut	15.8 ft./sec.	21.7 ft./sec.
Service ceiling ...	30,000 ft.	35,000 ft.
Take-off run to clear 50 ft.....	950 yds.	800 yds. *
Landing run to clear 50 ft.....	900 yds.	1,100 yds.
Range in still air .	1,725 miles	1,000 miles *

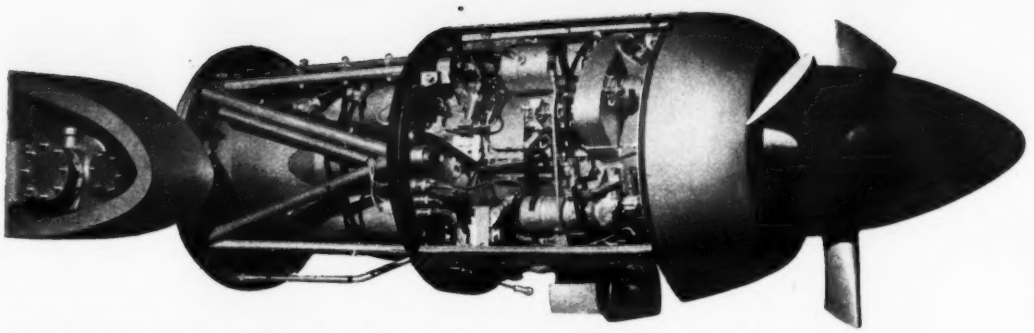
* Take-off weight can be raised to 39,500 lbs. and fuel supply to 990 Imp. Galls., in which case the take-off run would be 900 yds. and the range 1,500 miles.

have been avoided throughout : both undercarriage retraction and operation of the large-size Fowler flaps are carried out electrically.

The pressurisation system of the "Viscount" is supplemented by heating and humidifying equipment, thus providing complete air-conditioning. A cabin pressure corresponding to 8,000 feet can be maintained up to altitudes of up to 30,000 feet. Despite this considerable positive pressure, the cabin is provided with large oval windows, each of which can be opened from the inside or the outside in a case of emergency.

Most of the interior layout for 32 passengers has been built into the prototype, so that ultimate shortcomings as regards soundproofing, etc., can be spotted and remedied during the test flights. The layout is in accordance with the wishes of British European Airways : galley in the centre of the cabin, between a front cabin for 12 and a rear one for 20 passengers ; small luggage compartment facing the large door to the three-man cockpit. The "Viscount" can easily be equipped for accommodating up to 36 passengers.

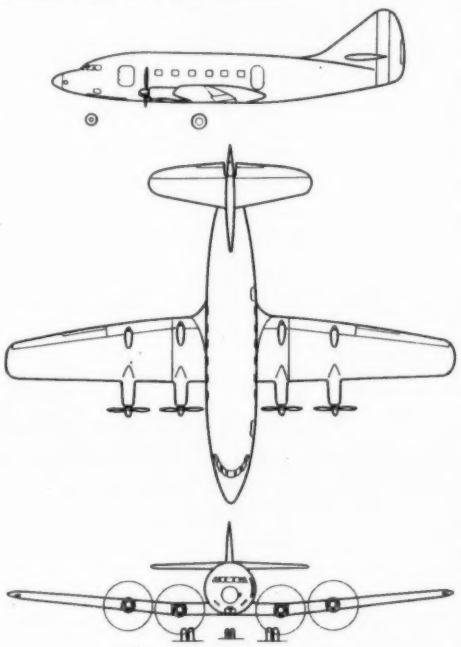
The most important features of the Armstrong-Whitworth "Apollo" concern two novelties in the control system. The rudder is built up from two halves hinged to each other, of which only the rear one is used in the usual manner. Not before this has been fully extended, is the front half adjusted (hydraulically), so that the pilot is freed from the effort of having to correct his course with the normal rudder in the event of a turbine failing. The second novelty is designed to damp out the undesirable effects of gusts during high-speed flight. It consists of a special differential gearbox introduced into



Full-scale model showing the installation of the "Mamba" and its accessories in the A.W. 55 "Apollo."

the aileron control circuit, which transmits the accelerations resulting from symmetrical or assymmetrical gusts on the ailerons, to a damping unit working with springs and hydraulic fluid. This incurs no loss of aileron control. The damping unit causes the ailerons to tend to float upwards or downwards, as incidence is increased or decreased, thereby alleviating the unpleasant effects of gusts, giving more even flight, and relieving structural aircraft stresses. By increasing the hydraulic pressure in the damping unit, the ailerons can be made to extend in the same direction, thereby supplementing the effect of the flaps.

Contrary to the "Viscount," the exhaust gases are ejected through nozzles on the wing upper surface, and thus furnish a certain amount of additional thrust.



Model of the Armstrong Whitworth A.W. 55 "Apollo," an airliner powered with four Armstrong Siddeley "Mamba" axial-flow propeller-turbines, which is approaching completion.

The normal fuselage division enables 31 seats to be installed, with a luggage compartment placed at the front end and a galley in the tail of the pressurised cabin.

The pressurisation system is dimensioned so as to maintain, up to an altitude of 25,000 feet, an interior pressure corresponding to 8,000 feet.

What chances have these two airliners, both of which make a good impression and are characteristic of the present determined efforts of the British aircraft industry, of finding a place in commercial aviation. Presupposing that during the tests, which will doubtlessly be thorough and lengthy, no unexpected technical difficulties, not to speak of accidents, arise, the only remaining question concerns their economic aspects. A rough estimation of the operating costs shows that it is the purchase and maintenance costs, rather than the fuel, that make the propeller-turbine slightly inferior, economically, to the piston engine. But precisely the calculation of these costs is still very unsure today, because nobody can say to what extent they will ultimately be reduced by the time such engines have been perfected in every way. However, it seems well worth while to attempt a large-scale trial once the test period is over.

But who can stand the risk of such a trial ? The present financial position of the British airline corporations is likely to cause them to shy before new experiments. With regard to these aircraft, the chiefly interested airline corporation, British European Airways, have already stated that they are temporarily shelving the idea of awarding production contracts for turbine-powered aircraft . . . However, shelved is not tantamount to abandoned ; and the success of the test flights of the "Viscount" and the "Apollo" may automatically determine the date on which even the most cautious of airline concerns will feel bold enough to transfer to propeller-turbines.

Large Turbine-Powered Airliners On the Way.

Conjectural as the success of these small turbine-powered passenger aircraft may be, if giant airliners are going to require outputs of over 3,000 or 4,000 H.P. per engine, then their propellers will just have to be driven by turbines. And such giant airliners are actually under construction in Great Britain. They are destined to enter service in a few years' time, chiefly on the Atlantic run, and are to accommodate around 100 passengers. One of

The Avro "Tudor IV," a 32-passenger airliner equipped with four Rolls-Royce "Merlin" engines, has been chosen as standard equipment for British South American Airways. Span 120 ft., length 85 ft. 6 in., take-off weight 80,000 lbs., cruising speed 305 m.p.h. at 25,000 ft., range 2,950 miles with 9,720 lbs. payload.

The Handley Page "Hermes II," an experimental version of the B.O.A.C. "Hermes IV" airliner for 40 passengers, which is to have a tricycle undercarriage ; power plant comprises four Bristol "Hercules 763" engines of 1,950 H.P .Span 113 ft., length 95 ft. 6 in., take-off weight 82,000 lbs., cruising speed 300 m.p.h. at 26,200 ft., range 2,400 miles with 11,400 lbs. payload at 9,850 ft.

these is the "*Brabazon,*" now nearing completion in its new, big hangar at *The Bristol Aeroplane Co. Ltd.,* at Filton, Bristol. The prototype, scheduled to begin test flights towards the end of this year, is still powered with eight Bristol "Centaurus" piston engines driving four pairs of contra-rotating propellers, but these are to be replaced with Bristol "Proteus" propeller-turbines in the second prototype. As in earlier years, this colossus is to be exhibited at the S.B.A.C. Display in model form to 1 : 24 scale.

And once again visitors will find a model of the *SR/45* giant flying-boat of 140 tons, being built by *Saunders-Roe, Ltd.,* at East Cowes, Isle of Wight. Its power plant is to consist of ten Bristol "Proteus" turbines ; four pairs of propellers will each be driven by two turbines, and the two outboard propellers each by one turbine. The first unit is not expected to start test flights until 1950 or 1951.

We call attention to these two aircraft because they involve problems which differ very greatly from those coupled with small and medium-size turbine aircraft. It must be remembered that neither the "Proteus" nor any other propeller-turbine of the same power class has so far been installed in an aircraft. No information on long-distance flights with turbines is available, nor have any such engines been carried up to the great altitudes affording them the best economic operating conditions. It is only step by step that one can approach such possibilities of experimentation.

These possibilities, however, will be brought nearer to realisation before the end of the year, by a new aircraft, or better said, by the turbine-version of a well-known airliner : the *Handley Page "Hermes V,"* powered with four Bristol "Theseus" units. This counterpart o the "Avro VIII" experimental jet airliner will feature the same interior layout as the "Hermes IV," built to B.O.A.C. specifications. Its cruising speed of 343 m.p.h. is close to the 357 m.p.h. maximum speed of the "Hermes IV" ; its range of 3,000 miles may be below that of the conventional version, but it is surely the longest range which turbine-powered aircraft will have for the next few years.

Conventional Airliners

Despite fervent hopes that airliners powered with propeller-turbines and jet engines will one day be used in the commercial field, the British aircraft industry is not relinquishing its efforts to supply the national airline corporations with the flying equipment they demand and urgently require in order to place their operations on a healthier economic basis. And for the present these are not radically new types which still have to be experimented with, but conventional pistoned-engined airliners embodying the classical design features which characterise airliners throughout the world today : all-metal monocoque construction, tricycle undercarriages, thermal de-icing, plentiful radio and navigation equipment, sufficient cruising speed and, in the case of types which have to fly longer distances, pressurised cabins with air conditioning ; but as main features throughout, operational reliability and simplicity of maintenance.

Transitional Types Developing.

As regards the "transitional" types begun during the last year of the War, which for their part had to replace still more primitive aircraft—converted bombers, at best equipped with more spacious fuselages—it was never intended that they should fulfil strict requirements, as the country was mainly concerned with getting something into the air quickly. But the competition set up by the Americans forced people to take notice ; and even before the transitional aircraft had been completed, one request after another was made for modifications. Accidents and the usual teething troubles worsened the situation. In view of Britain's dollar shortage, first-class foreign aircraft were only available in limited quantities. Therefore, these transitional aircraft had, and still have, to be put into service right away, and further developed under these conditions.

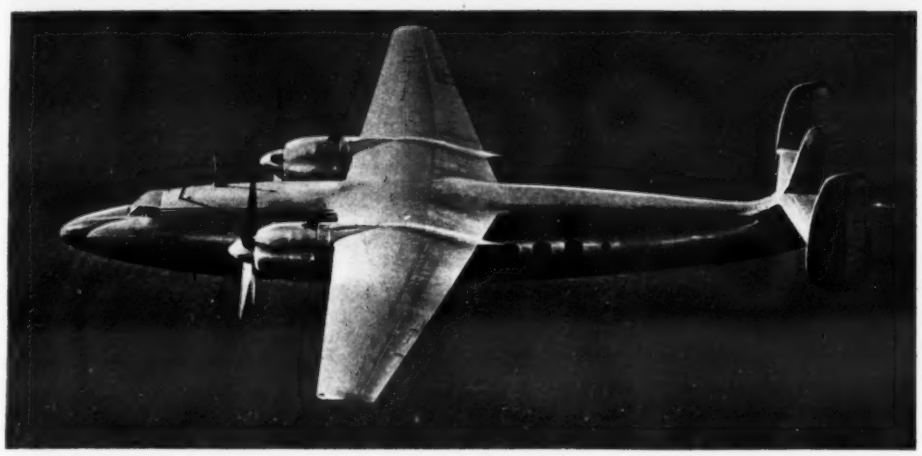
The stage which this further development has reached will be ascertainable from the new versions of types to be on show for the third time at an S.B.A.C. Display. But simultaneously, the military versions of the same aircraft, built for Royal Air Force Transport Command, will give an idea of what these basic types could have become if customers had not continually changed their minds : not very modern, not very economic, under no circumstance luxurious, but thoroughly reliable transport equipment if properly handled ; and which, for instance, would have been more than useful for the supply flights into and out of Berlin.

Much has been written about the four-engined *"Tudor"* series of *A. V. Roe & Co.,* of Manchester. It suffices to say that the 32-passenger "Tudor IV" version has now been chosen as standard equipment for British South American Airways. Either the "Tudor IV" powered with 1,740-H.P. Rolls-Royce "Merlin 621" engines, or the experimental "Tudor VII" with 1,715-H.P. Bristol "Hercules 120" units, already demonstrated in 1947, will appear at Farnborough this year.

The *Handley Page "Hermes IV"* for 40 passengers, of which B.O.A.C. have ordered 25 units, will likewise be demonstrated. Apart from a tricycle undercarriage, one of its main new features is its *electricity supply system,* built by *Rotax Ltd.* In place of the usual DC generator, which does not supply sufficient current until the engine is turning at about half of maximum r.p.m., alternating generators are used. These supply sufficient current over an r.p.m. range from 1 : 3.5, i.e., from idling to maximum r.p.m. They have a maximum output of 40 KVA at 8,000 r.p.m., and then furnish AC current of 400 cycles and 208 volts. This supply is transformed and rectified to the two DC supplies of 120 and 124 volts required by the aircraft. Used for the first time in an European aircraft, this system enables a weight-saving of 500 lbs. to be made in the "Hermes IV."

The stand of Handley Page Limited will also feature the model of a *"Hermes VI"* version, which is to have a smaller gross weight than the "Hermes IV" and generally represent a new stage in the development of this airliner.

The most-flown of British "transitional" airliners, the *Vickers "Viking,"* will be exhibited in military transport guise as the



The twin-engined Airspeed "Ambassador," the 40-passenger medium-range airliner destined for operation by British European Airways. Two Bristol "Centaurus 661" engines each furnishing 2,700 H.P. (soon to be stepped up to 3,000 H.P.). Span 116 ft., length 80 ft. 3 in., take-off 52,000 lbs., cruising speed 240 m.p.h. at 20,000 ft., absolute range 1,750 miles with 9,195 lbs. payload.

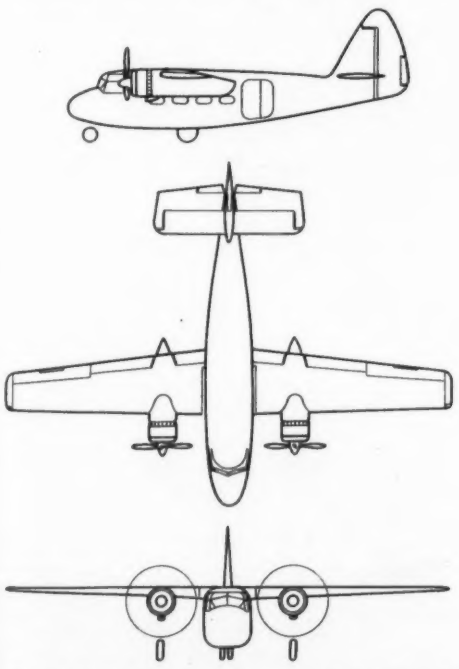
„Valetta," which has a reinforced floor, larger doors, bigger engines and an improved all-metal elevator unit.

By no means the least important of the transitional types are the numerous civil developments of the Short "Sunderland" flying-boat, which were used to maintain B. O. A. C.'s Empire links prior to their replacement with landplanes. One of the biggest of these, the *"Solent,"* will perhaps say a brief hello to visitors by flying over the exhibition field as it did last year.

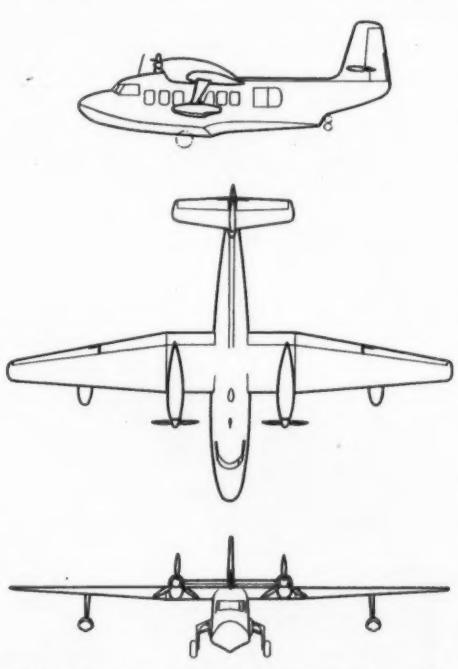
Realistic Future Planning.

Although a French proverb says that only provisional things will stand the test of time, Britain plans to do away with all today's transitional equipment, the sooner the better, and start operating really modern British-built aircraft. For the present place occupied by the "Hermes," the "Tudor," the "Canadair" and the American "Constellation," will either be taken by the D.H. 106 "Comet" jet airliner, or then by a more conventional new type with four 2,810-H.P. Bristol "Centaurus" piston engines, accommodating 40-50 passengers and known as the M.R.E. (Medium Range Empire) type. The Bristol Aeroplane Company have already worked out a design, the *Bristol 175,* in this respect, and are awaiting a firm order before proceeding further. It could be in service by 1954. A model will be on show at Farnborough, but no detailed information is available at the time of writing.

Much more advanced is the very modern twin-engined *"Ambassador"* high-wing monoplane airliner, of *Airspeed Ltd.,* which is to replace the "Viking" on the European network. It is designed for operating routes of about 1,000 miles, and seats 40 passengers. The first prototype made an excellent impression at Radlett last year, a second prototype has been completed except for the interior layout, and production of 20 units for British European Airways is proceeding, deliveries being expected for 1950. Both the second prototype and the production version will have pressurised cabins. Now designed for cruising at 240-312 m.p.h. at altitudes up to 20,000 feet, the "Ambassador" will also be equipped with propeller-turbines when the time comes, either with two "Proteus" or four Napier "Naiad" turbines.



Percival P. 50 "Prince" eight-passenger feeder transport. Two 595-H.P. Alvis "Leonides" radials. Take-off weight approximately 10,000 lbs., cruises 710 miles at 177 m.p.h.



Short "Sealand" amphibian for 5-8 passengers. Span 59 ft., length 42 ft. 2 in., take-off weight 9,100 lbs. The "Sealand" cruises 664 miles at 127 m.p.h. with 1,100 lbs. payload.

Aside from Planned Economy.

Let us now leave the "official" aircraft and turn to types which are likely to attract private owners and foreign customers.

The biggest of these, the proven multi-purpose twin-engined *Bristol 170,* will be exhibited in its new version with rounded wing tips, a span increased by ten feet, superior payload and range. Between the "Freighter" cargo version, for loads of up to about 12,000 lbs., and the "Wayfarer" all-passenger model providing 32-36 seats, there are to be various combinations for mixed loads of passengers and cargo ; a military transport version is also in preparation.

The *"Universal Transport"* four-engined cargo aeroplane of *General Aircraft, Ltd.,* is expected to carry still greater loads. However, it will not be completed before next year.

The four-engined *"Marathon"* civil transport, for a two-man crew and 13-18 passengers, was originally developed by Miles Aircraft Ltd., which is now a branch of the Handley Page concern and known as *Handley Page (Reading) Ltd.* One of these aircraft, with its four 330-H.P. de Havilland "Gipsy Queen" piston engines replaced with two "Mamba" propeller-turbines, is to start flight tests soon.

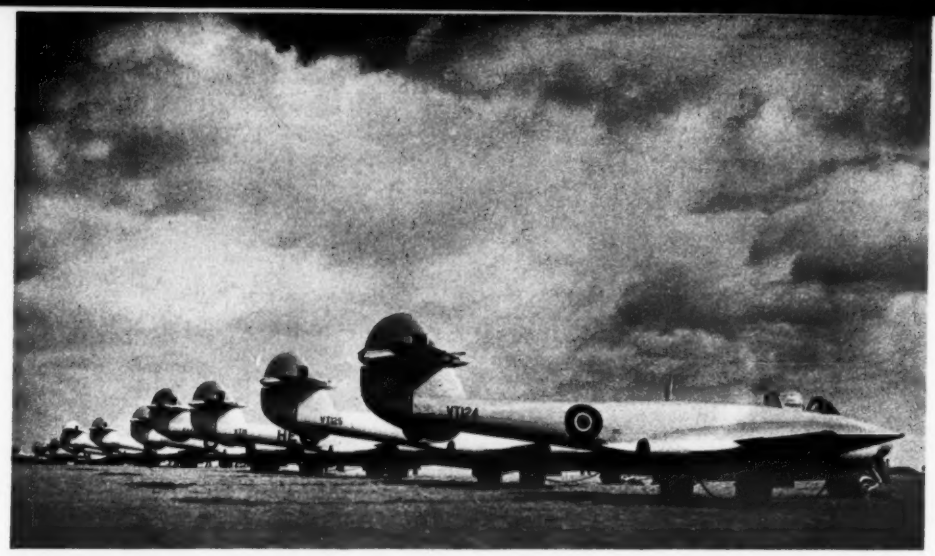
This year's Display will mark the first appearance of the *Percival P.50 "Prince,"* a twin-engined high-wing monoplane built to accommodate eight passengers, which has been developed from the "Merganser" prototype of last year. The 300-H.P. "Gipsy Queen 51" engines of the prototype have now been replaced with two 505-H.P. Alvis "Leonides" engines in the "Prince."

Another newcomer to the S.B.A.C. Display will be the *Short "Sealand"* amphibian transport for six to eight occupants, which made its first flight last January. In place of the two "Gipsy Queen 71" engines of 330 H.P. built into the prototype due for demonstration, a later version will be powered with Alvis "Leonides" engines, which will enable the ICAO take-off requirements to be fulfilled. In principle, it is a thankless task to produce an amphibian of these dimensions with respectable performance characteristics, but it was tried and successfully accomplished with a view to satisfying the transport requirements of certain remote districts. As a pure flying-boat, the "Sealand" could carry considerably more payload than the present version with its heavy retractable undercarriage.

Finally, *The de Havilland Aircraft Co. Ltd.,* will be exhibiting its well-known *"Dove"* twin-engined feeder-line transport, which is now being produced in large series and from which the Australian subsidiary of the de Havilland concern has developed a promising three-engined aircraft, the *"Drover."* The latter will be used primarily in instances where small or primitive airfields make it impossible for the "Dove" to meet the ICAO take-off requirements.

Military Aircraft

This year, too, the demonstration of British military aircraft at the S.B.A.C. Display is likely to be a fine showing, in which test pilots will show their perfect mastery of fast and heavy aircraft, giving the crowd the best possible chance of seeing the good flight characteristics. It would seem that this time the main attraction of the aerial demonstration will be the pilots' virtuosity, since most of the aircraft are likely to be known and proven types.



A "Meteor 4" squadron of the Royal Air Force.

Jet Fighters.

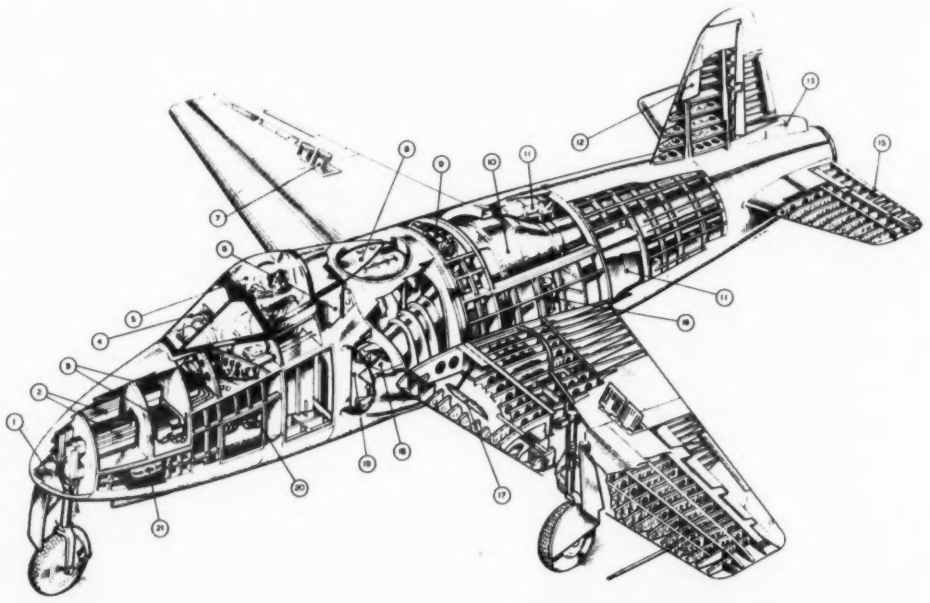
The development of British jet fighters has reached a high level and a certain limit of perfection. Especially the "Meteor" and "Vampire" are being produced in large series, and finding plenty of customers among foreign air forces.

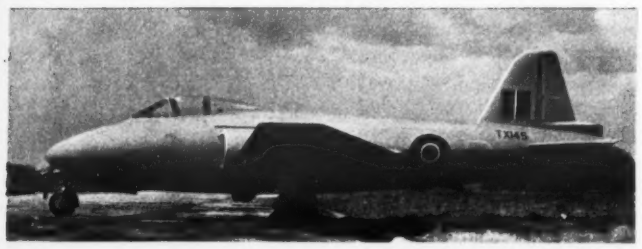
The twin-engined "Meteor" of *Gloster Aircraft Co. Ltd.*, has now been standardised on the clipped-wing *"Meteor 4"* version. Its two engines give it climbing ability and manoeuvrability which even the very latest U.S. types could exceed by only a very slight degree. For training pilots to fly this fighter, a two-seater version, the *"Meteor 7,"* has been built. Except for the extra seat, it does not differ from the "Meteor 4" and, at all events, does not feature inferior flight characteristics. On the other hand, a *variant of the "Meteor 4"* is to be unveiled to the public at this year's S.B.A.C. Display, thus giving evidence that development of this aircraft, already of some years' standing, is not being neglected. In place of the two "Derwent" turbo-jets with radial compressor, the variant is powered with Metropolitan-Vickers axial-flow "Beryl" jet engines, which are of much smaller diameter. As, moreover, these engines furnish a somewhat greater thrust than the "Derwents," they will also enable higher speeds to be reached. Their installation required a modification to the spars of the wing centre section. These spars are of steel, and now form a bridge over the engine instead of the former closed annular spar of the normal versions.

The experimental *Gloster E.1/44* single-seater powered with a Rolls-Royce "Nene," of which the prototype was severely damaged in an accident to the truck transporting it to the testing centre last year, will also be demonstrated. It is remarkable for an extensive utilisation of steel in the wing construction, the presence of special flaps beneath the leading edge of the inboard portions of the wing, for recovering from dives, and the installation of dive brakes on the upper surface of the inboard and outboard portions of the wing. An anti-spin parachute is enclosed in a container located above the fuselage tail. It is not intended to produce the E.1/44 as a standard fighter.

Last year, *Hawker Aircraft Ltd.* brought out their *N.7/46* jet fighter, which was only

Gloster R.1/44 experimental jet-propelled aircraft, powered with one Rolls-Royce "Nene." Span 36 ft., length 38 ft. 1 : Cabin ventilating pipe. 2 : Electrical accumulators. 3 : Radio. 4 : Windscreen de-icing. 5 : Electrically-operated hood. 6 : Front fuselage fuel tank. 7 : Air brakes. 8 : Main fuel tank. 9 : Auxiliaries gearbox. 10 : Rolls Royce "Nene 1" gas-turbine. 11 : Rear fuselage fuel tanks. 12 : Surface aerial. 13 : Tail parachute. 14 : Elevator trim tab. 16 : Hydraulic reservoir. 17 : Dive recovery flap (port and stbd.) 18 : Engine air intake duct. 19 : Boundary layer bleeder duct. 20 : Electrical main panel. 21 : Pneumatic air container.

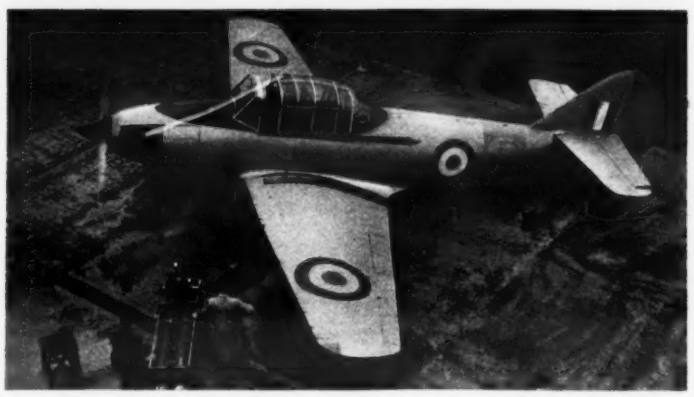




Gloster "Meteor 7," new two-seater training version of the "Meteor 4."

The de Havilland "Vampire 3," standard long-range version of the famed R.A.F. fighter.

The new Vickers-Supermarine "Seagull" for air-sea rescue service. Its Rolls-Royce "Griffon" drives contra-rotating propellers. Span 50 ft. 6 in., length 44 ft. 1½ in., gross weight 14,500 lbs., maximum speed 260 m.p.h. at 11,800 ft., range (with two extra tanks) 1,230 miles.



Avro "Athena 1" three-seater advanced trainer powered with a "Mamba" propeller-turbine. Span 40 ft., length 36 ft. 6 in., design maximum speed 287 m.p.h. at 10,000 ft., landing speed 80 m.p.h. The "Athena 2" version with a Rolls-Royce "Merlin 35" of 1,280 H.P. has roughly the same flight performance.

shown in small-scale model form at Radlett. It has two jet nozzles, one located on either side of the fuselage, and both joining on to the same Rolls-Royce "Nene" turbo-jet. It is considered likely that this fighter will also be shown to visitors at Farnborough.

Of the light *de Havilland "Vampire"* jet fighter, two versions, the "Vampire 3" and "Vampire 5," are being built for the Royal Air Force. The main external difference between the *"Vampire 3"* and its predecessors concerns the new rudder configuration, which is shaped roughly like a quarter of an ellipse. This version is primarily for long-range duty. The newer *"Vampire 5"* version has two-foot-shorter wing tips and is specially designed for low level attacks.

Among other jet fighters which will participate at this year's S.B.A.C. Display, mention should be made of the especially fast *Vickers-Supermarine "Attacker,"* and the *Saunders-Roe S.R./A1* fighter flying-boat equipped with two Metrovick "Beryl" axial-flow turbo-jets.

Piston-Engined Aircraft.

The heavy bombers of the R.A.F., it would seem, are a family concern of *A. V. Roe & Co., Ltd.,* whose four-engined *"Lincoln"* forms the backbone of Bomber Command. A newer type, but designed as a long-range reconnaissance aircraft for over-water duty, is the *Avro "Shackleton"* which, like the "Lincoln," is derived from the famous "Lancaster." The "Shackleton" has four contra-rotating pairs of propellers, each pair being driven by a Rolls-Royce "Griffon 57" of 2,350 H.P. take-off power, with single-stage supercharger. No further information on this aircraft, of which the appearance at Farnborough depends on the Air Ministry's decision, is available for the time being.

A great number of the many small and medium-size aircraft which will complete the R.A.F. picture at Farnborough this year, are already well known. We shall therefore confine this account to a few new developments.

The twin-engined *Short "Sturgeon"* Naval reconnaissance bomber, designed for carrier-borne operations, is to appear in a *"Sturgeon 2"* version (with slightly longer fuselage) for towing targets.

In place of the Vickers-Supermarine "Sea Otter" air-sea rescue aircraft, the amphibious biplane which created an odd aspect at Radlett last year, visitors to Farnborough will see the *Vickers-Supermarine "Seagull,"* a single-engined high-wing monoplane of which the wing's angle of incidence can be altered during flight, to suit either high-speed or slow-landing requirements. Fitted with split flaps, the wing has a slotted leading edge extending over the entire span, and can be folded to facilitate storage on board aircraft carriers.

Other exhibits will be new versions of the *Fairey "Firefly"* two-seater Naval reconnaissance fighter, the *"Firefly 5"* with elaborate radio and radar equipment, and another version designed for target-towing duty.

Auster Aircraft Ltd., who will show a more strongly built trainer version of their "Auster 6" light observation aircraft, the *"Auster 7,"* announce a new type designated *A.2/45.* This will presumably fulfil the same part as the A.O.P. type demonstrated at Radlett last year on behalf of Heston Aircraft Ltd., which bore the same specification number.

Trainers with Turbines and/or Piston Engines.

The first aircraft powered solely with propeller-turbines to become airborne were two advanced training aircraft, the *"Balliol 1"* of *Boulton Paul Aircraft Ltd.,* and the *"Athena 1"* of *A. V. Roe & Co., Ltd.,* which were both developed to meet the same competition rules drawn up by the Air Ministry, and therefore bear a marked resemblance to one another—the main difference concerns the design of the fuselage tail and tail assembly—each being powered with an Armstrong Siddeley "Mamba" turbine of 1,010 H.P. The second prototypes of these aircraft, the *"Balliol 2"* and *"Athena 2,"* however, have liquid-cooled Rolls-Royce "Merlin 35" piston engines of 1,280 H.P. The Boulton Paul P.108, flown at Radlett last year, was none other than the first version of the "Balliol," powered at the time with a Bristol "Mercury" radial, as no turbine-propeller was available. The *"Balliol 3"* will probably be equipped with another make of propeller-turbine, a Rolls-Royce "Dart."

The three versions of the Boulton Paul "Balliol" advanced trainer, counterpart of the "Athena": (left to right) "Balliol 2" with Rolls-Royce "Merlin 35" in-line, "Balliol 1" with "Mamba" propeller-turbine, and P. 108 with Bristol "Mercury" radial of about 1,000 H.P. Span 39 ft. 4 in., length ("Balliol 1") 36 ft. 6 in., design maximum speed (at 10,000 ft.) 302 m.p.h. for "Balliol 1" and 299 m.p.h. for "Balliol 2."

Model of the Planet "Satellite," a new four-seater personal aircraft of all-magnesium monocoque construction, powered with either a de Havilland "Gipsy Queen 31" of 250 H.P. or a Gipsy "Major 10" of 145 H.P. Span 33 ft. 6 in., length 26 ft. 3 in., gross weight 2,905 lbs. (2,280 lbs. with "Gipsy Major 10"), payload 925 (707) lbs., range with above payload 1,000 (500) miles.

Civil Trainers and Personal Aircraft

Last year, *Fairey Aviation Co., Ltd.,* took over from their Belgian subsidiary the manufacturing rights for the "Tipsy Belfair" primary trainer, and are now producing it in Britain under the name *Fairey "Primer."* It is a low-wing monoplane of composite construction, with seats in tandem and a fixed tail-wheel undercarriage, and will participate this year for the first time in an S.B.A.C. Display.

From their "Auster 7" military trainer and "Autocrat" personal aircraft, *Auster Aircraft Ltd.* have recently developed a four-seater touring aeroplane, the *"Avis,"* which is of the same construction as the two original types.

The *Chrislea "Super-Ace"* is a new four-seater personal aircraft with fixed tricycle undercarriage and twin fin and rudder unit. Although it is generally regarded as a successful design, criticism is frequently directed against the unusual manner of operating the elevator, executed by moving the aileron control wheel up and down.

Finally, a relatively young London firm, *Planet Aircraft Ltd.,* has completed the prototype of a four to five-seater personal aircraft, the *"Satellite,"* which deserves praise for both the boldness of its design and the simplicity of its construction. It is a low-wing monoplane with the engine positioned behind the cabin, between luggage compartments inside the fuselage, and coming to lie above the level of the wing ; via an extension shaft, it drives a propeller placed aft of the tail assembly. The undercarriage is of retractable tricycle design. There is a "butterfly" type of tailplane with a fixed vertical fin extending downwards so as to form a Y-shaped tail assembly, thus resulting in simplified control with only two degrees of freedom. The fuselage is of pure monocoque construction, thick zirconium-magnesium sheeting with a minimum of stiffening being used. The wing, for example, is built up in strips of alloy, of thickness varying between 1.2 and 4 mm., which form a bending and torsion-resistant monocoque structure which has no supporting spar. The rear fuselage portion is a true cone of pure monocoque construction, without any interior reinforcement, and can quickly be separated, by releasing an interior frame, from the front half so as to provide access to the engine in the event of a major overhaul.

Helicopters

The first helicopters to be of practical utility were developed in the U.S.A. during the War. British research in the rotary-wing domain, which had formerly been fostered energetically by La Cierva and his co-workers, was almost forced to a standstill during the period of hostilities. After the War, the British firm of Westland Aircraft Ltd. came to an agreement on manufacturing rights with the Sikorsky Division of United Aircraft Corp., and the parachute firm, Irving Airchute of Great Britain Ltd., organised licence production of Bell helicopters. But now already, serial production of purely British helicopters is advancing considerably, and despite the extremely complex mechanical problems involved, quite a number of types represent something more than experimental constructions.

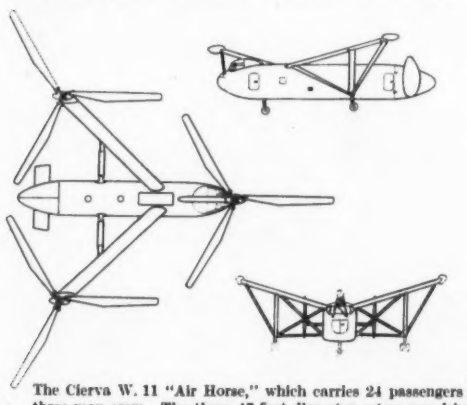
The *"Gyrodyne,"* designed by Dr. J. A. J. Bennett and developed by *Fairey Aviation Co., Ltd.,* is chiefly characterised by its system of rotor torque compensation. Instead of a tail rotor with its axis of rotation perpendicular to the direction of flight, it features a pusher propeller positioned on one side of the fuselage. This contributes greatly towards forward propulsion, and therefore allows for a reduction in the forward inclination of the rotor plane, which other helicopter designs normally require for moving forwards. Since the main rotor does not have to contribute so much towards forward propulsion, its angles of blade pitch can be kept small and do not have to be reduced before a safe auto-rotation descent can be made if an engine fails.

The Bristol 171 helicopter accommodates four occupants and has a three-blade rotor. Test flights have hitherto been made with two prototypes, both provisionally powered with Pratt & Whitney 450-H.P. engines. Production versions will have the Alvis "Leonides" furnishing 505 H.P. for take-off.

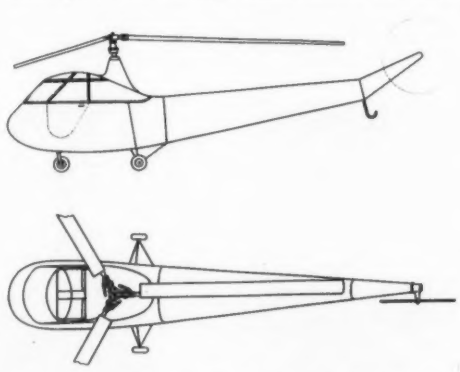
A 505-H.P. Alvis "Leonides" drives the three-blade rotor. The "Gyrodyne" established an international record for helicopters on June 28th last, when it twice covered a 3-km. course at an average speed of 124.3 m.p.h.

The contribution of *The Bristol Aeroplane Co., Ltd.,* to this field is the *Bristol 171* four-seater helicopter designed by Raoul Hafner. Like Sikorsky and Bell types, it has a rear anti-torque rotor.

Finally, the *Cierva Autogiro Co., Ltd.,* who last year demonstrated their W.9 experimental type with anti-torque achieved by an exhaust nozzle, announce a big and a small helicopter. The *Cierva W.11 "Air Horse"* has three rotors and can be used for carrying 24 passengers or 3-4 tons of freight. Its power plant is a Rolls-Royce "Merlin 24" engine of 1,620 H.P. Their small product is the *Cierva W.14 "Skeeter,"* a two-seater destined for large-scale production, which has a conventionally-arranged rotor and rear anti-torque propeller, and a 110-H.P. air-cooled engine. *T.*



The Cierva W. 11 "Air Horse," which carries 24 passengers and a three-man crew. The three 47-foot-diameter rotors are driven by one Rolls-Royce "Merlin 24" of 1,620 H.P. Maximum span is 95 ft., maximum length 88 ft. 7 in., and gross weight 17,500 lbs.



The Cierva W. 14 "Skeeter" two-seater helicopter with 110-H.P. engine. Rotor diameter is 28 ft., 5 in. and fuselage length, including rear anti-torque rotor, 27 ft. 3 in.

The Shark in the Goldfish Pond

or

The Application of P. A. A. for Domestic Routes.

The Root of the Matter.

"Unfair competition... skimming the cream off the U.S. airline trade... driving the domestic traffic to ruin..."

Nearly every time officials of the U.S. Civil Aeronautics Board open the mail, they find letters containing similar forceful expressions. And the victim of all this vehemence is Pan American Airways, Incorporated, known also as Pan American World Airways, and for short as Panam or just PAA.

Their biggest opponents are the other four of the Big Five in the U.S. air transportation : American Airlines, Trans World Airline, United Air Lines, and Eastern Air Lines. What is it that has caused these companies to boil up and bombard the CAB with letters day after day ? Why is it that eight other U.S. airline companies, all domestic operators, are also up in arms against Pan American Airways ?

On the surface, the reason is simple enough. On June 9th, 1948, PAA submitted an 85-page brief (Docket No. 1803) to the CAB, applying for certificates to operate eight domestic routes within the continental U.S With these routes, PAA wish to join together and feed their intercontinental services, all of which end at the coasts and borders of the U.S.A. This is how the picture looks on the surface.

Behind the entire affair, however, is a chunk of airline history on which books could be written. Coupled with this problem is the present and future development of U.S. commercial air transportation—one might even go so far as to say world aviation. At all events, PAA have been causing the CAB headaches for quite some time.

A Monopoly.

To whom did the major airline routes belong up to the outbreak of World War II ?

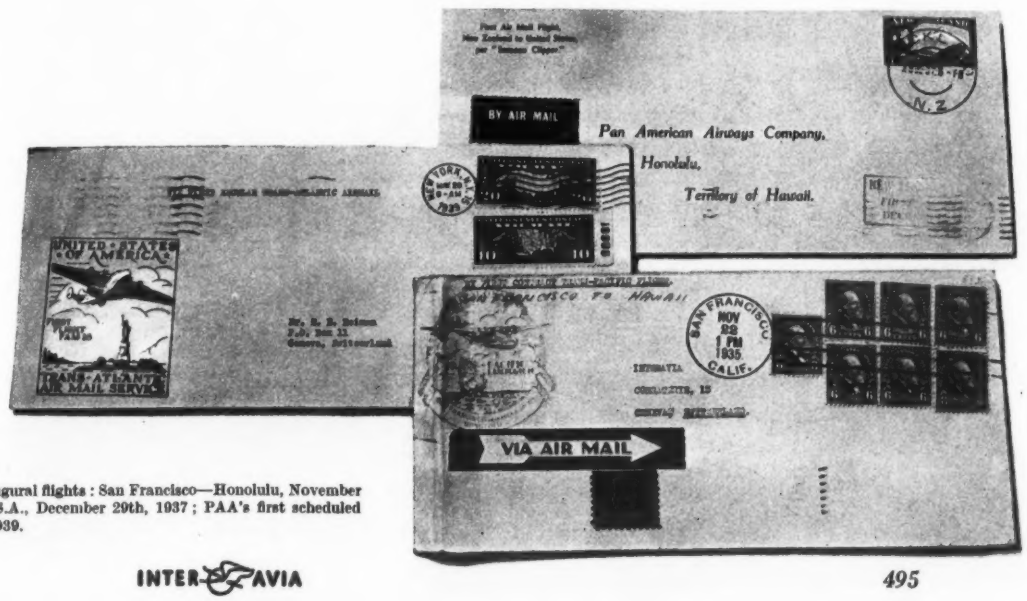
In October, 1927, KLM Royal Dutch Airlines opened their Amsterdam—Batavia route, thus bridging Europe and the East. In 1928, the French Aéropostale carrier established an air link between Europe and Africa, and later, South America. The British carrier, Imperial Airways, began flying to India, and was later followed in that direction by the French Air Orient concern. In 1935, Sabena joined Belgium with the Congo. And in 1936, the German Lufthansa started frequent services in the South and later North Atlantic areas, after having established outposts in South and Central America, the Near East, and for a short time even in Russia.

But the U.S.A. did not remain idle.

It sounds paradoxical to say that U.S. overseas air transportation owes its creation—at least indirectly—to speculation in the cotton market. In 1926, a U.S. Air Corps officer, Captain H.R. Harris, was sent to Peru in order to take care of certain cotton business deals. How this business fared is beside the point. It so happened that soon afterwards he was fed up with the cotton trade. But more than the other cotton speculators, he recognised the transportation poverty of Latin America, and surmised that this continent would provide a unrestricted field of activity for commercial air transportation. And one fine day he visited the president of W. R. Grace & Co., the big shipping company. His negotiations there were followed by a number of results. Pan American-Grace Airways was founded, for air services between North and South America, Pan American Airways, Inc., for services from the U.S.A. to foreign countries, and a parent company, Pan American Airways Corporation. Under the latter's roof there are today at least sixteen airline companies, based in various parts of the world. They are also contemplating the establishment of a hotel concern, with threads running to points all over the globe.

Juan Terry Trippe, President of Pan American Airways.

Since 1931, the presidential reins have been in the hands of Juan Terry Trippe, who, incidentally, is a brother-in-law of the indus-



PAA clippers over the world's oceans. Airmail letters marking inaugural flights : San Francisco—Honolulu, November 22nd, 1935 ; by "Samoan Clipper" from New Zealand to the U.S.A., December 29th, 1937 ; PAA's first scheduled Atlantic mail flight from New York to Marseilles, May 20th, 1939.

trial magnate and former U.S. Foreign Secretary, Edward R. Stettinius. Known as one of the most capable, experienced, proudest and toughest men in civil aviation, Trippe has excellent connections—for example, his brother-in-law, Stettinius. Well equipped in all ways, he fulfilled the rôle assigned him, by acquiring for Pan American a monopoly for intercontinental air transportation. This monopoly was in no way anchored, either legally or contractually, but was silently recognised—perhaps unwillingly—by the U.S. Government and the U.S. airline companies.

In memory of the clipper ships which built up America's overseas trade, PAA's aircraft were also made known as "Clippers". And during the War, when free-thinking Europeans turned their eyes towards the outside world, they turned them towards Lisbon. In that port were moored the "Clipper" flying-boats of PAA, for long years the only envoys from the Free New World.

* * *

Other airline companies arose in the U.S.A. Around the end of the '20's, several small companies were merged to form United Air Lines, known under this name since 1934. American Airlines arose as successor to American Airways, founded in 1929. The joining together of a number of small carriers in the southern States led to the formation in 1930 of Transcontinental & Western Air, Inc., better known today as Trans World Airline. And in 1934, Eastern Air Lines was separated from the General Motors group's aircraft firm, North American Aviation.

These four major airlines, and about a dozen small carriers, limited their operations to domestic services—apart from a few routes to Canada and Mexico—up to 1939. On the American overseas network, not a single U.S. carrier stood in the way of Pan American. And at the outbreak of the last war it seemed as though this traditional carrier of U.S. overseas airline trade was destined to inherit from the majority of European airlines—especially from the Lufthansa—and thus become the undisputed ruler of the airspace over the oceans.

Matters took another course.

One Man's Meat...

The Japanese bombs which fell on Pearl Harbour on December 7th, 1941, put a stop to PAA's plans. The U.S.A. emerged from neutrality to become a belligerent power, and required the services of all U.S. airline companies, big and small, to maintain overseas connections.

Matters did not stop at this. By 1942 already, it became apparent that certain official circles in America were toying with the idea of doing away with PAA's monopoly. In June of that year, Brigadier General George, Commanding General of the U.S. Army Air Transport Command, summoned the heads of the airline companies to discussions in Washington—in which his Chief of Staff, Colonel C.R. Smith, president of American Airlines, took part as a matter of course. These men, including General George and especially his Chief of Staff, agreed that there was no sense in their taking the trouble to organise elaborate overseas networks during the war, just to abandon them afterwards. The call arose for free competition, removal of all barriers... only under these conditions could the airline trade progress healthily. And in 1943, sixteen U.S. domestic operators put forward demands which were tantamount to a strong desire for the removal of Pan American's overseas monopoly.

Typically enough, at that time three airlines declared their opposition to unlimited freedom of traffic: United Air Lines, of course Pan American Airways, but also American Export Airlines. Out of the latter was to grow American Overseas Airlines and PAA's strongest competitor. But in 1943, these three companies gave birth to the "chosen instrument" concept for U.S. airline operations—a single airline monopoly, backed by the State, to carry the U.S. flag around the world. In November, 1943, W. A. Patterson, president of United Air Lines, suggested to the CAB that U.S. domestic carriers be excluded from the intercontinental field of operations. Perhaps he has long since forgotten that.

Meanwhile, the "chosen instrument" champions did not see their wishes fulfilled. Leading industrial circles in the U.S.A., among others the U.S. Department of Commerce, were in favour of free competition; and PAA were not liked by everybody.

* * *

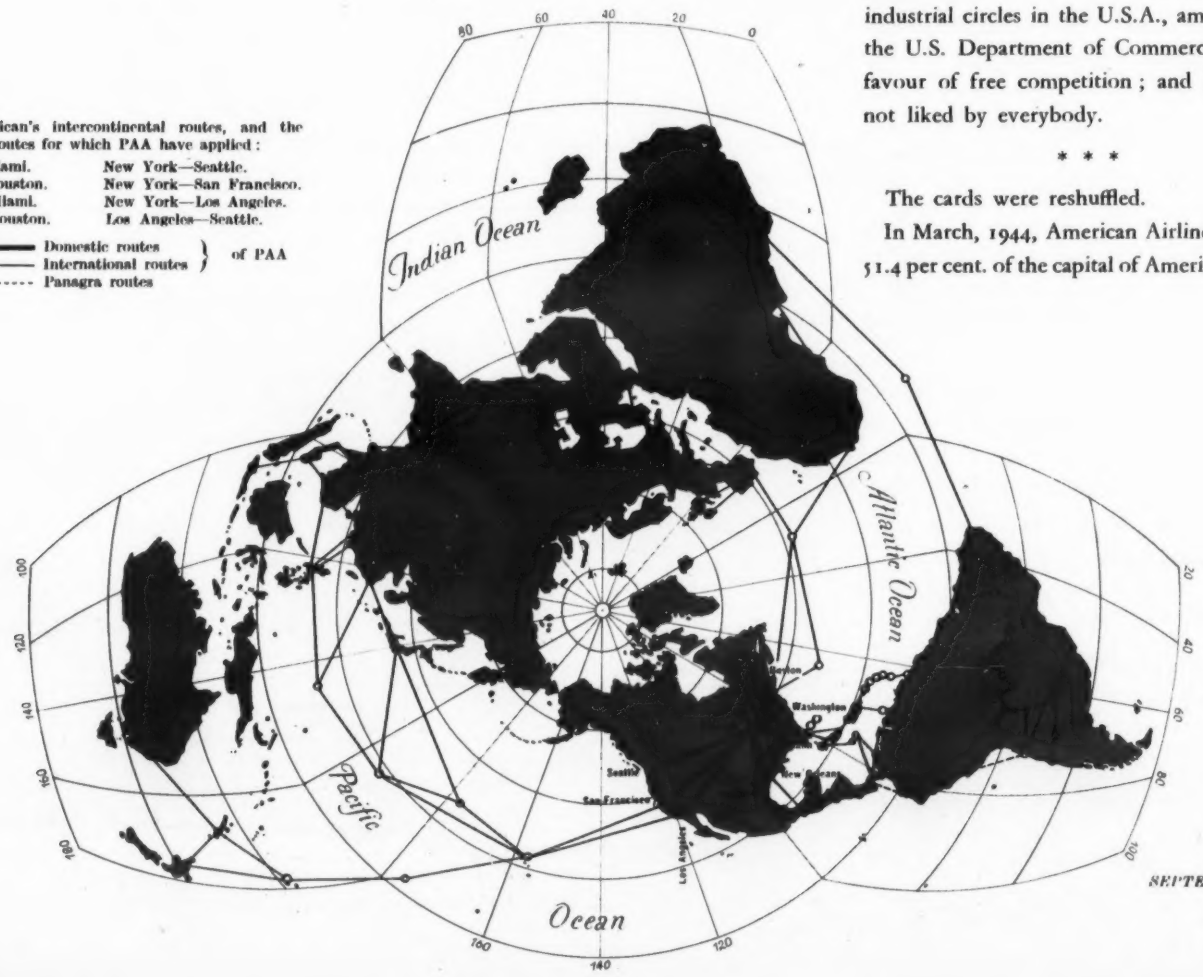
The cards were reshuffled.

In March, 1944, American Airlines acquired 51.4 per cent. of the capital of American Export

Pan American's intercontinental routes, and the domestic routes for which PAA have applied:

Boston—Miami.	New York—Seattle.
Boston—Houston.	New York—San Francisco.
Chicago—Miami.	New York—Los Angeles.
Detroit—Houston.	Los Angeles—Seattle.

Domestic routes
International routes } of PAA
Panagra routes



Airlines, the Atlantic operation formed in 1937 by the American Export Lines shipping concern. At the end of the War, this carrier, now known as American Overseas Airlines and 62 per cent. owned by American Airlines, was granted a CAB certificate for the northern Atlantic route extending to the Far East via the Soviet Union—an extension which is wishful thinking for the time being. TWA obtained a route through the heart of Europe—Paris, Geneva, Rome—to Cairo and on to the Far East via India. By a decree of August 1st, 1946, this grew into a round-the-world route, with one section flown by Northwest Airlines. Other airlines, too—even a sworn domestic operator like United Air Lines—started leaving the continental U.S. and flying to all points of the compass.

What was PAA's reaction to this ? Their answer was perfectly logical. If their monopoly was to be invaded through the granting of overseas route certificates to domestic carriers, then they would also take a hand in domestic operations and declare war on the interested companies.

But Mr. Trippe's belligerent plan was easier said than done. For he apparently underestimated the opposition of the Civil Aeronautics Board, without whose permission "no sparrow could hop from one branch to another" or—more prosaically stated—no domestic or foreign route could be flown by a U.S. airline company.

It was apparent, therefore, that the U.S. domestic operators understood "free competition" as applying only to PAA's foreign routes, and not to this airline's competition in the domestic field.

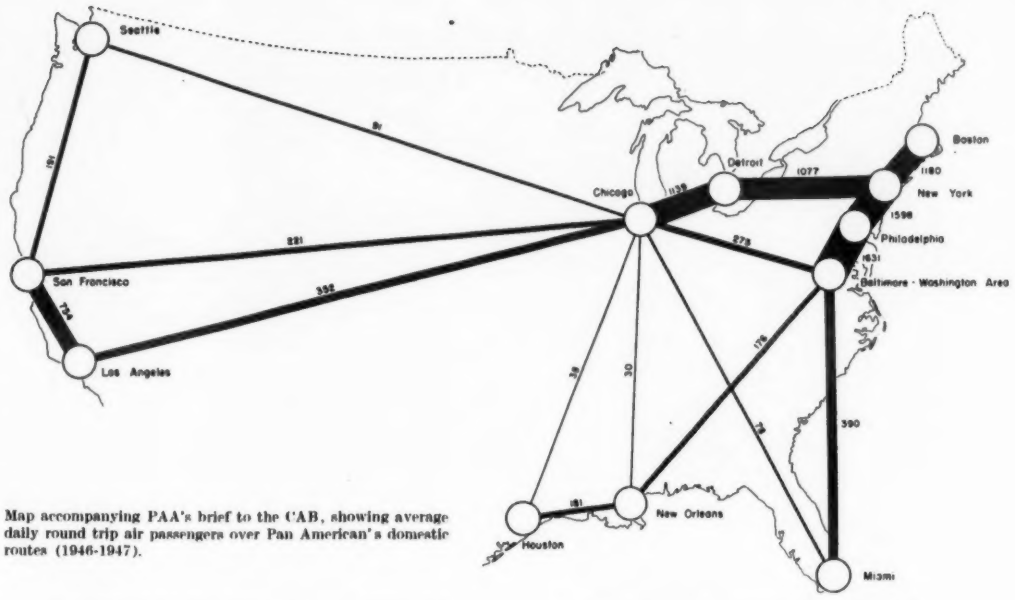
One man's meat is another man's poison.

The Indiarubber Paragraph.

By the terms of the Civil Aeronautics Act of 1938, the granting of certificates for new routes was assigned to the Civil Aeronautics Administration, the highest authority in U.S. civil aviation matters. Later, in 1940, this authority was given to the Civil Aeronautics Board.

Issuance of certificates in compliance with PAA's application for domestic routes is dependent on the CAB's interpretation of Section 401 of the Civil Aeronautics Act :

> "The Authority shall issue... if it finds that the applicant is fit, willing and able to perform such transportation properly, and to conform to the provisions of this Act... and that such transportation is required by the public convenience and necessity."



Map accompanying PAA's brief to the CAB, showing average daily round trip air passengers over Pan American's domestic routes (1946-1947).

In an administrative procedure of this nature—in America as in all countries—such legal phrasings play a secondary rôle. In spite of official regulations, one takes one's stand behind common sense and generally proven principles arising from experience.

"Public convenience," "necessity"... these are terms which are cherished by lawyers, but which lend considerable elasticity to considerations of fairness and principles of good faith. Precisely Section 401 of the U.S. Civil Aeronautics Act is what might be termed an an indiarubber paragraph : it can be stretched and made to suit the requirements of many different cases.

Pan American have not been slow to seize on this feature in their application for domestic operating rights. Their statement boils down to the following :

1) International air transportation service—not only that of PAA but also that of all U.S. overseas air carriers—would be greatly improved if passengers, property and mail had not to change aircraft at the national frontiers but could continue in the same aircraft—thus those of PAA—directly to their point of destination. Such a facilitation would double the flow of foreign passenger traffic and be to the great benefit of the American taxpayer. For example, PAA's operating costs for foreign operations could have been reduced by at least $5,000,000, had they been authorised to extend their routes inland ; moreover operating revenues would have been increased by $6,000,000 (PAA furnish tables to illustrate these points). On air mail costs alone, the U.S. taxpayer would have made savings to the extent of 55 per cent.

2) The U.S. Government had no right to deny PAA—a purely American undertaking—the authority to operate to U.S. cities, when it granted such authority to foreign carriers. PAA's application is not only in the interest of U.S. prestige and economy, but very much in the interest of national defence. — The PAA general counsel drew attention to an example where the U.S. Government had granted the advantages of a single-carrier service to a foreign airline, Peruvian International Airways, which are now denied to PAA : "If the man in the street, the man who uses American-flag air services, or the man who pays the bill for them, were to be told that this country was allowing a so-called Peruvian airline to offer direct service without change of plane between New York and Washington on the one end, and Panama, Peru and Chile on the other, but was denying this privilege to the American-flag airline that had been serving those South American countries for nearly twenty years, I think he would simply not believe it. He would say this would be a tariff in reverse—protection for the foreign operator and a wall against our own."

3) Without domestic routes, PAA's ability to compete will be reduced by 50 per cent. on the Atlantic, 55 per cent. on the Pacific route to Hawaii, and by 80 per cent. on services to Central America.

4) Without domestic routes PAA will be in a position neither to fulfil the rôle assigned them as America's traditional foreign operator, nor to complete their organisation effectively. Without domestic routes, PAA's Alaska Division at Seattle, Pacific Division at San Francisco, Latin America Division at New York, cannot work effectively.

Representatives of the aviation authorities of thirteen major U.S. cities have requested Government approval of Pan American's proposed domestic routes, testifications being submitted by New York, Miami, New Orleans, Houston, Los Angeles, San Francisco, Seattle, Washington, Philadelphia, Boston, Detroit, Baltimore and Chicago. Approval of PAA's application would give these cities single-carrier services to the sixty-four countries and colonies lying along PAA's network.

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An advertisement by Peruvian International Airways, which PAA used to point out advantages of through-carrier services granted by the CAB to foreign operators and not to American-flag airlines.

But there are more opponents than protagonists, for PAA are at war with almost every airline company in the U.S.A.

The Money Side.

The battle is being fought by both sides with the same amount of vigour that characterises most economic battles in the U.S.A. There is no lack of publicity either. PAA, for example, reproduce an advertisement by Peruvian International Airways who ask "Are you a misguided missile—changing planes—misplacing baggage—missing connections... change to PIA's direct, no change of plane Siesta Service." Pan American used PIA's language to answer : "Why *should* this country require a passenger travelling on his *own* airline to be a 'misguided missile, changing planes, and misplacing baggage,' instead of affording a service that is 'direct, no change of plane.' How can any agency charged with the duty of advancing *American* air transportation allow such a situation to continue ?" Further condemning the CAB priorities given to foreign operators, PAA draw attention to a ruse which United Air Lines used in an advertisement— "Mainliner 300 leaves New York at midnight, crosses the Pacific during daylight, arriving in Honolulu at 5.10 p.m. the same day ! 'Hawaian Mainliner' flights to Honolulu—United's new western terminus..." —which PAA say is "nicely phrased to give the erroneous impression that a through-plane service is provided between New York and Hawaii."

PAA's opponents are not exactly gentle in their criticisms. "Revenge growing out of their losing battle to retain a monopoly of American-flag international air services" say TWA. United Air Lines state that PAA's proposal "strikes at the very heart of route segments which have been and are now the backbone of the nation's domestic air transportation system" adding that PAA "boldly seek routes from coast to coast" which would "skim the cream of traffic from the domestic routes," ruining them by "vicious competition."

However, there are two sides to every picture.

The U.S. airlines are not doing too well at present. Contrary to most of the European companies—biggest competitor being British Overseas Airways—the American carriers are based on private enterprise. Granted, they receive a kind of subsidy in the form of air mail pay. But they have to earn their own bread if they are not to go hungry. And rations were meagre during 1947. American Airlines lost nearly $3,000,000, without taking into account the $1,400,000 interest they had to pay on preference shares. United reported a loss of about $3,750,000. American Overseas Airlines found themselves about $1,775,000 short at the end-of the year—a loss which must be compensated in some way or other by the parent company, American Airlines. TWA's present financial position is sufficiently well known. Eastern Air Lines represent the only domestic carrier to report a profit—about $1,250,000, largely thanks to the acumen of President Eddie Rickenbacker. And the nearly $3,000,000 profit made by PAA on foreign operations did not help to make this carrier any more popular.

It is in these figures—not in the above-stated reasons and arguments—that the problem of U.S. domestic air transportation lies ; and also, therefore, the future of Pan American's application.

A good idea of the position of domestic operators is given by the accompanying table, covering the results of the four main carriers during the first quarter of 1948 ('000 omitted) :

	Net Operating Deficit		Revenue Load Factor (%)	
	1947	1948	1947	1948
American ..	$4,837	$4,997	64.2	57.7
Eastern	+1,623	+2,495	68.3	61.6
TWA.....	3,438	1,202	59.7	58.3
United	5,132	3,884	69.5	60.7

And by April, 1948, these results grew even worse.

* * *

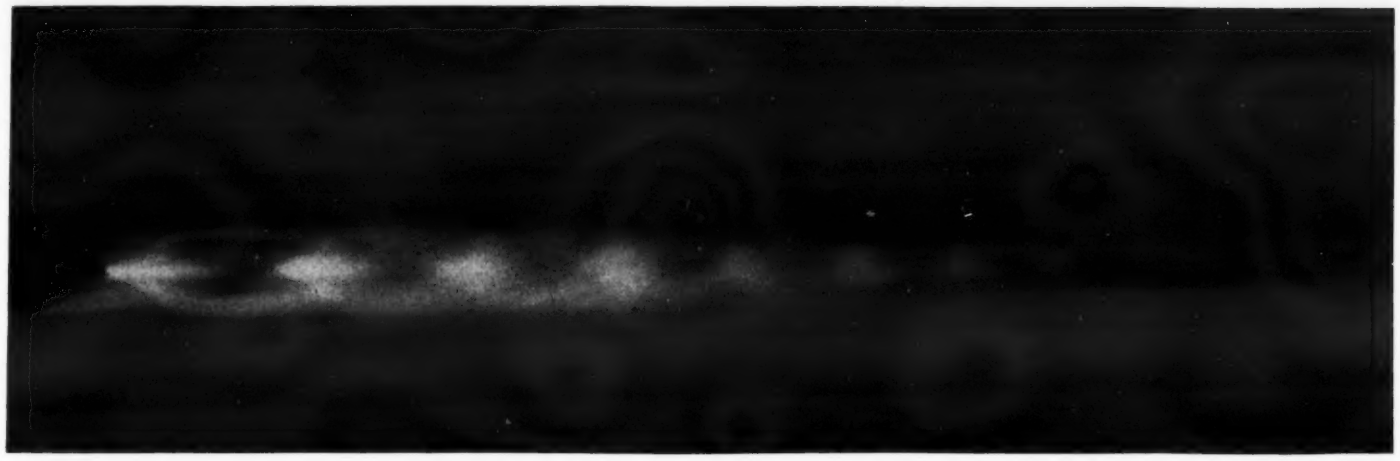
The U.S. Civil Aeronautics Board is now expected to take a decision which will be in the interest of "public convenience and necessity," thus fair to all concerned and profitable to the American taxpayer. The CAB has repeatedly explained that its decisions are always based on future planning. But what does the future hold in store ?

It cannot be denied that Pan American Airways, as the traditional U.S. foreign operator—and also known as such in foreign countries—occupy a special position in American and international airline trade. It is furthermore not to be denied that operating solely overseas routes means exposing oneself far more to crises than operating only domestic routes ; besides this, a world organisation costs more to build up and maintain than a purely domestic organisation does. Pan American Airways did not start erecting, even before the war, hotels on lonely Pacific islands just for fun, or for the convenience of the natives. Nor should PAA be regarded as a purely expansionist company because they are now starting their "Intercontinental Hotels Corporation," aiming to provide accommodation for their passengers in numerous South American countries. The fact remains that, from the standpoint of operations and world organisation, Pan American are unbeatable at the present time.

Anyone who entertains the idea that it is a simple matter to make money in overseas operations alone, would do well to recall the TWA crisis and those days in 1947 when this airline company was seriously considering the idea of cutting down foreign operations to a minimum. The President of TWA at that time, Jack Frye, who was successful in domestic operations but suffered severe setbacks in the international field, declared when resigning that he was unable to agree with the views of his main shareholder, Howard Hughes, concerning the operation of an intercontinental network. The denial of his successor was again denied in May, 1948, when TWA once more seemed to be at the end of their tether.

Let us summarise the matter.

Viewed superficially, the CAB has to decide whether New York, Washington, Boston and other major U.S. cities are or are not to be served by a number of additional big airlines. But behind this decision are hidden perspectives of far-reaching significance. What could be granted to Pan American Airways tomorrow might *have* to be granted to other airline companies—and possibly foreigners—the day after. After all, the CAB is occupied in a field in which it may perhaps some day find itself in the presence of a national monopoly company. And the decision must be doubly difficult to make, since it does not only concern economic but also political factors of the greatest importance.



Nodes of oscillation, visible with naked eye, in efflux jet of high-pressure rocket propelled by 1 tonne of gas oil and liquid oxygen.

The Prospects of Jet Reaction Flight

By Dr. Eugene SAENGER, Paris.

A. *General*

Lasting among new technological developments of World War II are notably atomic energy, for which most credit goes to the U.S.A., radar, a primarily British contribution, and jet reaction, a mode of propulsion fostered originally by Germany.

Throughout almost forty years, aircraft have been developed exclusively in conjunction with reciprocating engines. Dictated by the requirements of the last war, there suddenly arose a whole series of new prime movers for aircraft, such as resonance ducts, turbine-jet power plants, rocket engines, and aero-thermodynamic ducts (athodyds or ram-jets), which enables us to speak of a new branch of aeronautical engineering: *aircraft propulsion by thermal jet reaction.*

The understandable interest, from the scientific, technical, commercial, military, political and general public standpoints, evinced by the wide vistas lying before this new mode of flight propulsion, justifies an attempt to assess it. However, such an assessment must necessarily remain a strictly personal venture, even though the aeronautical scientist called upon to offer his views, is able to base himself on a large number of real facts and conditions, particularly physical ones, which will in all probability find practical application and thus point out to the engineer the way ahead.

The aim in air transport, as in every technical branch of transport, is the carriage of given loads over pre-determined routes. A primary implication in connection with jet reaction flight technique, concerns an increase in the transport speed together with a maximum restriction, or even a reduction, in the operating costs. Flying greater distances and at greater altitudes, thus bringing aircraft further away from the surface of the globe, is only a secondary implication.

SYMBOLS

a	sonic speed (m/sec.)	i_{pH}	shock during collision (kg/m²)	F	area, wing area (m²)	Z	number of collisions of molecules (dimensionless)
c	effective efflux velocity (m/sec.),	i_{pR}	shock after collision (kg/m²)	F_2	frontal area (m²)	α	angle of incidence (°), heat transfer coefficient (kcal/m²h°)
c_a	lift coefficient (dimensionless)	i_τ	shock parallel to wall (kg/m²)	G	weight (kg)	α_r	local angle of incidence (°)
c_w	drag coefficient (dimensionless)	k	coefficient (dimensionless)	G_o	original weight (kg)	α_{sl}	angle of incidence of compression shock (°)
c_m	moment coefficient (dimensionless)	l	length of flow (m)	H	flight altitude (m)	α_x	local angle of incidence of a fore-positioned surface element (°)
c_s	thrust coefficient (dimensionless)	m	mass (kg.sec²/m)	H_u	lower calorific value (kcal/kg)	Δ	finite change (dimensionless)
c_p	specific heat at constant pressure (kcal/kg°)	p	pressure (kg/m²)	K	force (kg)	ϵ	lift/drag ratio c_w/c_a (dimensionless)
c_H	most probable molecular velocity before collision (m/sec.)	p_m	nozzle pressure (kg/m²)	L	output (mkg/sec)	λ	thermal conductivity (kcal/mh°)
c_R	most probable molecular velocity after collision (m/sec.)	p_o	pressure in combustion chamber (kg/m²)	M	molecular weight (dimensionless)	σ	high-temperature stability (kg/m²)
d	diameter, wing thickness (m)	q	dynamic pressure $v^2/2$ (kg/m²)	P	thrust (kg)	τ	frictional tension (kg/m²)
f	rocket cross-sectional areas (m²)	s	trajectory (m)	P'	free thrust (kg)	ρ	density (kgsec²/m⁴)
f'	smallest flame-tube cross-section (m²)	t	time (sec), wing chord (m)	Q	quantity of heat (kcal/sec)	η	efficiency (dimensionless)
g	acceleration of gravity (m/sec²)	t_f	fire-edge temperature (deg. C.)	R	radius of earth (m), individual gas constant (m/°)	κ	polytrope, adiabatic exponent (dimensionless)
		t_k	cool-edge temperature (deg. C.)	$\Re$	general gas constant (m/°)		
		v	flying speed (m/sec.)	Re	Reynolds number (dimensionless)		
		v_1	initial speed in gliding flight (m/sec.)	T	absolute temperature (deg. K.)		
		w	velocity of flow (m/sec.)	V_o	combustion chamber volume (m³)		
		A	mechanical equivalent of heat (kcal/mkg)	W	drag (kg)		

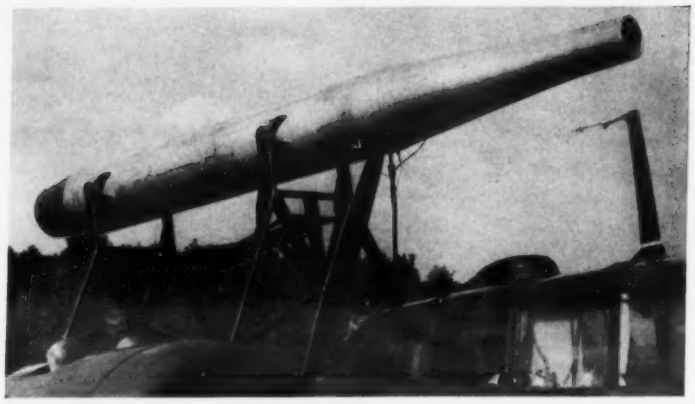


Fig. 1: Installation for tow tests of high-temperature athodyd of 0.5–m. diameter and 5.5–m. length. Carrier aircraft is a Dornier Do 217 twin-engined bomber.

The first means of propulsion from this series of new aircraft prime movers, to be put into practical application, was the *resonance duct*, which was unable to fulfil its designers' hopes as regards speed. Even for the future, its prospects are only moderate. Nevertheless, it succeeded, under special transport conditions, in reducing the operating costs to such an extent that it will not disappear completely without further ado.

The second new type of power plant to find general introduction was the *turbo-jet engine*. Although it did not reduce the operating costs, it offered a wider range of operational flying speeds, within the range of about 700 to 1,000 km/h. Further increases in speed, even to a piercing of the sonic barrier, may be anticipated once the present airframe limitations have been overcome. Meanwhile, its operational speed will be kept within the above-mentioned limits, since more suitable propulsion systems are available for higher flying speeds, which are still in the experimental stage owing to the lag in airframe development : *ram-jet engines* and *rocket power plants*.

Chemical fuels will definitely remain in the lead during the next decade of aeronautical development. Their earlier replacement by atomic energy is hardly to be imagined.

The utilisation of these classical fuels presents a determinant factor for both the operating costs and the range of aircraft, thus leaving the concept of engine efficiency as an important index, even though the very different fuel bases of modern aero engines and the influences of constructional costs and absolute output have already narrowed down this concept's earlier cardinal importance.

Fig. 2 reveals the unique superiority of the piston engine with propeller throughout almost the entire subsonic speed range, the immense importance of the ram-jet within the range of Mach 1 to 4, and the exclusivity of pure rocket propulsion for still faster aircraft. The separate peak efficiencies are particularly prominent. Worthy of note is the pronounced efficiency gap in the vicinity of sonic speed (~1,000 km/h), about where the turbo-jet engine begins to find application. The latter's field of application is not limited to the subsonic range, but its efficiency at higher supersonic speeds naturally goes over towards the more simple ram-jet engine as soon as the ram compression of the latter becomes comparable with the compression effect of turbo-jet engines. Turbo-jet engines are therefore indicated for flying speeds around Mach 1, in which domain, however, many aircraft reveal unfavourable polar curves and, consequently, short ranges.

Most noticeable from the curve pertaining to the resonance duct is that the efficiency values are very low throughout. The eventual economic superiority of this engine is therefore solely attributable to its low constructional costs, a circumstance which confronts us again when considering the subsonic ram-jet engine. Though this has oddly escaped practical engineering so far, it may lead to a replacement of the resonance duct by the subsonic ram-jet engine for flight at high subsonic speeds.

Thus it may be seen that, for the outgoing era of chemical fuels in aeronautics, two systems of aircraft propulsion are coupled with the main prospects of jet reaction flight : *ram-jet engines* and *rocket power plants*.

B. *Ram-Jet Propulsion*

1. *Working Principle.* Known for thirty-five years thanks to the proposals of Lorin, the principle of this engine mainly consists of designing a duct in such a way that air continuously streaming in against flight direction is first decelerated and compressed, then heated, and finally ejected at accelerated speed, whereby the entire procedure is completely continuous and requires no rotating part.

The revolutionary technical significance of this principle of propulsion is that it no longer calls for special engine nacelles which, today, are developed separately from the aircraft and attached or built into the finished airframe, but that it rather represents a design principle for fuselages or wings in order to make the latter's drag negative so that power plant and also the aerodynamic forces due to drag, lift, and propulsion of the entire aircraft, combine with one another and obey common aerodynamic laws.

2. *Thrust Coefficient versus Mach Number.* If the frontal area F_2 of the engine is sufficiently large in comparison with the cross-sectional area F_1 of the air intake, then the vector sum of all gas pressure differences as compared with the undisturbed ambient air pressure p_1 at the engine walls (as long as they are caused by the air masses flowing through), thus the " thrust P, " may be expressed with good approximation by the formula :

$$P = \rho_1 F_1 v^2 \left[\sqrt{T_3/T_2} \sqrt{\frac{1-\left(\frac{p_1}{p_1+\Delta p}\right)^{\frac{\kappa-1}{\kappa}}}{1-\left(\frac{p_1}{p_1+\Delta p/\eta_D}\right)^{\frac{\kappa-1}{\kappa}}}} - 1 \right]$$

wherein ρ_1 signifies the density of the undisturbed air and v its speed, T_3 the absolute ram temperature of the in-flowing medium and T_2 that of the out-flowing medium, thus $(T_3 - T_2)$ the amount by which it is heated ; Δp the pressure increase really attained in the diffuser and $\Delta p/\eta_D$ the pressure increase attainable through adiabatic compression.

The diffuser efficiency η_D at subsonic speeds is always close to unity, but at supersonic speeds this only arises in a case of adiabatic compression.

For supersonic diffusers with perpendicular compression shock at the entry, the following formula is approximate :

$$\eta_D = \frac{\Delta p}{\Delta p_{is}} = \frac{\frac{4}{\kappa+1}(1-a^2/v^2) + \frac{(\kappa-1+2a^2/v^2)\,[9\kappa-1+(6-4\kappa)\,a^2/v^2]}{[2\kappa-(\kappa-1)\,a^2/v^2]\,4\,(\kappa+1)}}{\frac{\left[\frac{\kappa-1}{2}v^2/a^2+1\right]^{\frac{\kappa}{\kappa-1}}-1}{\frac{\kappa}{2}v^2/a^2}}$$

In the case of adiabatic compression, thus especially at subsonic speeds, the thrust formula may be expressed more simply :

$$P = \rho_1 F_1 v^2 \left(\sqrt{T_3/T_2} - 1\right)$$

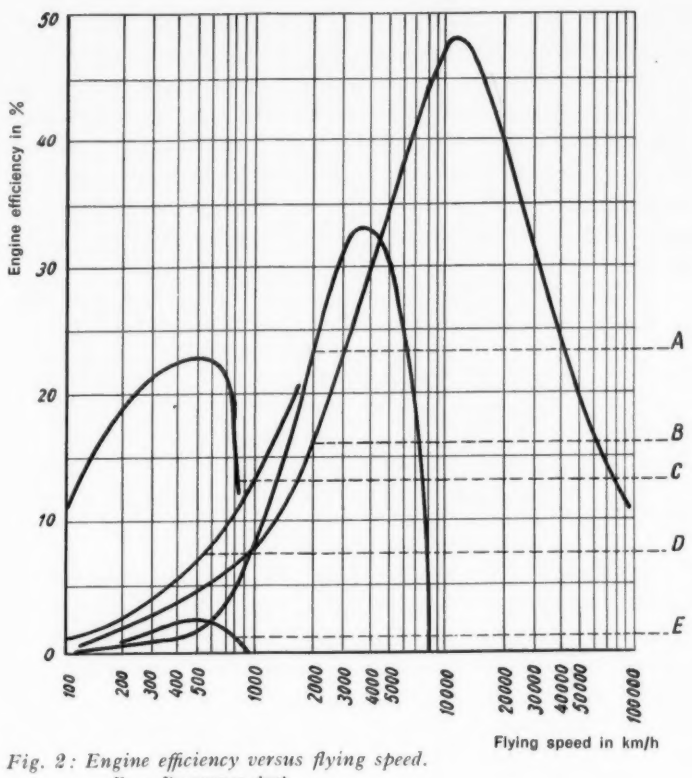


Fig. 2: Engine efficiency versus flying speed.
E = Resonance duct
D = Turbo-jet engine
C = Piston engine with propeller
A = Athodyd
$\Delta T = 1{,}000°$ C.
B = Oil-oxygen rocket
c = 3,200 m/sec.

At subsonic speeds, if profile diffusers are used, the gas outlet cross-section F_4 can be fixed and F_1 can be variable, thus yielding a simpler formula :

$$P \approx \rho_1 F_4 v^2 \left(1 - \sqrt{T_2/T_3}\right)$$

$$\text{Condition :} \quad \frac{F_4}{F_1} \approx \sqrt{T_3/T_2}$$

The engine efficiency is simply :

$$\eta = \frac{A P v}{Q}$$

if $Q = \rho_1 F_1 v g c_p (T_3 - T_2)$ is the quantity of heat transmitted and A the mecanical equivalent of heat.

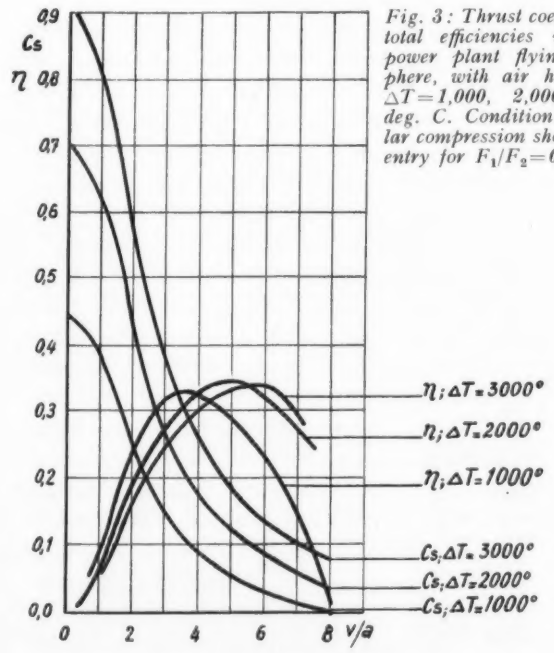


Fig. 3: Thrust coefficients c_s and total efficiencies η of athodyd power plant flying in stratosphere, with air heated through $\Delta T = 1{,}000$, 2,000 and 3,000 deg. C. Condition: perpendicular compression shock at diffuser entry for $F_1/F_2 = 0.16$.

Fig. 4: Tow test of high-temperature athodyd of 0.5–m. diameter and 5.5–m. length ; gasoline combustion ; thrust coefficient c_s = approx. 0.47.

For the thrust forces, we can define a thrust force coefficient $c_s = P/qF_2$ in the same manner as for the other air forces, and find that the curve of these thrust coefficients versus the Mach number is very similar to the well-known curve of the air force coefficients, as for example Fig. 2 shows, *i.e.*, at subsonic speeds, air forces which increase, practically, with the square of flying speed, and later slower, only decreasing once considerable Mach numbers are attained.

Correspondingly, the entire engine efficiency also increases, initially with the square of the flying speed and attaining a maximum at high Mach numbers, this maximum being dependent on the magnitude of the temperature increase and also on the degree to which compression in the engine diffuser has been achieved adiabatically.

3. *Engine Diffusers.* With $F_1/F_2 = 0.16$, Fig. 3 shows the conditions for the practical limit case with perpendicular compression shock at the diffuser entry.

This limit case shows lower efficiencies than in the case of adiabatic compression, but leads up to an especially simple constructional design of engine diffuser, which is suitable without adjustment for the entire Mach range, and which is recognisable in Figs. 3, 4, 5 and 6, where an experiment on a flying test stand is presented, showing the results in the form of the pressure distribution measured in a rotationally-symmetrical engine.

Alongside this type of classical diffuser, in the form of a truncated cone, studies were also conducted at supersonic speeds with the oblique-shock diffusers designed by Oswatitsch, which separate the individual perpendicular compression shocks into a multitude of oblique shocks and thereby attain less adiabatic increase ; at subsonic speeds, the profile diffusers of Ruden were found to be advantageous, particularly as regards more favourable possibilities of regulating the engine.

Whereas straight diffusers create engine thrust by means of positive pressure at the interior walls, the profile diffusers do this by means of negative pressure, thus local accelerations at the diffuser nose. Owing to this, the application of profile diffusers becomes all the more restricted as sonic speed is reached, as can be seen from a case presented in Fig. 7, where an exceeding of the local sonic speed at the diffuser nose is not permissible.

Fig. 5: Installation for tow tests of a high-temperature athodyd of 1.0–m. diameter and 8.6–m. length. Carrier aircraft is a Dornier Do 217.

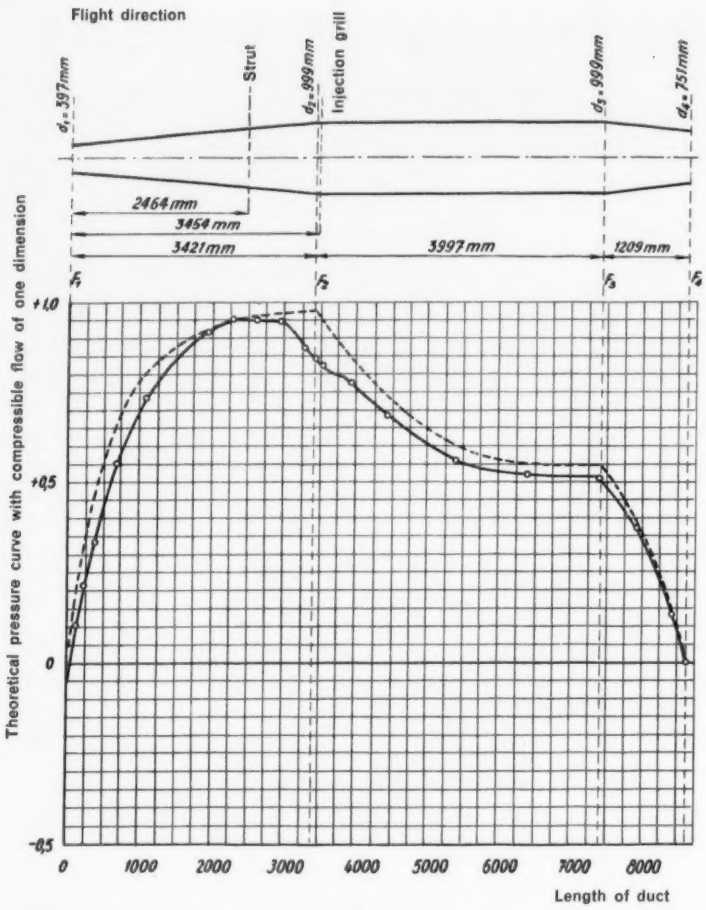


Fig. 6: Curve measured from ratio of interior positive pressure Δp to dynamic pressure q_{kompr} versus length of Lorin duct, at 4 kms. altitude with full power applied (full-line curve).

H = 4 kms.; q = 546 kg/m²; v/a = 0.352;
p = 6,075 kg/m²; T_o = 265 deg. K.

4. *Heating with Oil.* For heating ram-jet engines with liquid fuel, the injection grill shown in Fig. 8 has proven its utility in flight tests. The regular distribution of a large number of injection nozzles over the entire flow cross-section enables good macro-mixture to be effected ; injection against the direction of flow increases the relative speed and the storage life of the fuel in the combustion chamber, thereby yielding good mixture preparation ; finally, the utilisation of twist-injection nozzles enables micro-mixture to be achieved.

This arrangement enables exceptionally complete combustion to be achieved at altitudes up to 7,000 metres, even with only moderate injection pressures and without pre-vaporisation of the fuel. The behaviour of the turbulent liquid-fuel combustion at lower air pressures presents a special research problem, concerning which only partial results, though very positive in character, have been attained so far.

5. *Heating with Coal.* As regards heating ram-jet engines with liquid coal, it seems that no data gained from experience is available, although this method might be of commercial significance.

On the other hand, however, extensive data are available on heating with solid coal, showing in the main that the speed and speed change of solid coal combustion can at best satisfy the requirements of horizontal flight at steady subsonic speed, and could not be used for fast ascents or supersonic flight.

6. *Heating with Atomic Energy.* In principle, the ram-jet engine is well suited to the utilisation of atomic heating in the form of an atomic radiation heating, which exploits the high absorption capacity of the air for α and β particles. One could imagine the distribution of the radiation sources over a grill, similar to the distribution of injection nozzles presented in Fig. 8, so that the range of a few centimetres, as possessed by these nuclear particles in air compressed as it is here, enables the flow section to be covered evenly.

7. *Combustion Chambers.* The third important element of the ram-jet engine, alongside the diffuser and the heating, are the combustion chambers. Instead of the originally-used constant-pressure combustion chambers, whose cross-sections increased proportionally to the heating of the air, preference is now given to cylindrical combustion chambers of the type shown in Figs. 4, 5, 6 and 8, in which the gas pressure during the heating process, particularly at subsonic flying speeds, drops noticeably.

8. *Fire Walls.* The usually high gas temperatures make it necessary to build combustion chambers of thin-walled metal shells, whose outer walls are exposed to the relative wind and thereby cooled very thoroughly.

The critical thermal requirements in athodyds concern the region lying downstream of the end of the diffuser, and differ according to whether the flight is at subsonic or supersonic speed.

At subsonic speeds, it has been seen from flight experience that, in the case of stoichiometric combustion of hydrocarbons at a temperature of 2,400° K., wall temperatures of up to 600° C. occur roughly one metre behind the injection grill at 100 m/sec. flying speed, whilst the wall zones situated further aft are somewhat cooler. This temperature maximum is attributable to radiation from the reaction zone exceeding the gas convection and normal gas radiation. This peak temperature would probably become less apparent at higher flying speeds, because the heat loss by convection increases with the flying speed.

Under these conditions it is to be assumed that, at high subsonic speeds, air temperatures up to 4,000° K., obtained by nuclear reaction, could be used without endangering engine walls of high quality steel.

The thermal requirements are considerably stricter at supersonic speeds. The compression temperature in the diffuser increases by about $v^2/2{,}000$° C., where v is the flying speed in m/sec. The temperature increase due to friction at the duct's outer walls amounts to about 85 per cent. of the total temperature, thus, for instance, causing a boundary layer temperature of 1,500° K. at a Mach number of $v/a = 5.9$, which must also be regarded as the upper limit of the wall temperature of the ram-jet ; *i.e.* at this flying speed the cooling

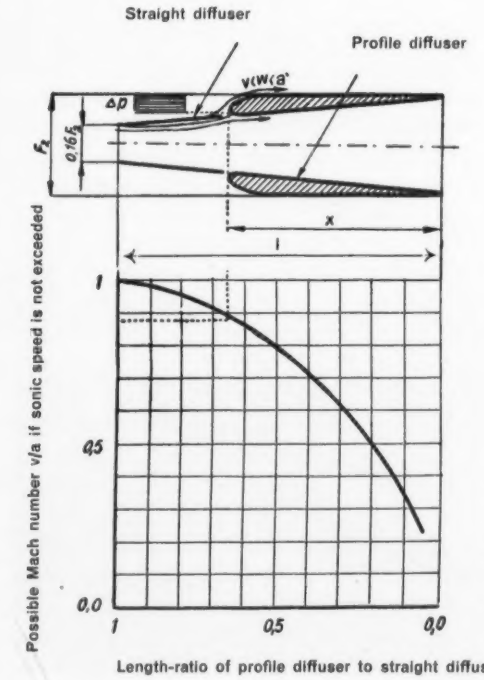


Fig. 7: Permissible approach of flying speed to sonic speed, using a part-profile diffuser instead of a straight diffuser, if the local speed of flow around the diffuser nose does not exceed sonic speed.

effect of the relative wind has completely disappeared and the wall may not be further heated from the interior. With heat-resistant steel as constructional material and without special cooling processes, the flying speed of the ram-jet engine is therefore absolutely limited, for thermal reasons, at the above-mentioned Mach number. In practice, the limit is even lower.

Fig. 10 shows the compression and frictional temperature plotted against the Mach number. In the area above 2,060° C., and higher —owing to the increasing specific heats of the gases—less above the compression temperature curve, runs the curve of the flame temperatures of stoichiometric combustion of gasoline. With the aid of the usual gas convection calculation there may be plotted, in approximation, a wall temperature curve which lies between the curves of the combustion temperature and the frictional temperature, and cuts the temperature limit of heat- and oxidisation-resistant steels, of 1,500° K., at about $v/a = 3.5$. Higher flying speeds under the above conditions, with a ram-jet engine functioning at full power with gasoline, are not possible for thermal reasons.

Every other type of heating to the same temperature yields practically the same limit speed. Atomic heating to higher temperatures, of course, presents correspondingly lower limits.

An extension of this limit, by using lower combustion temperatures, as shown in Fig. 10, is only possible as long as the then decreasing thrust cœfficient suffices to overcome the drag cœfficient of the engine moving at steady speed, and then only within very narrow limits.

During all attempts to raise the speed limit of the engine, it must furthermore be borne in mind that the airframe's walls are also under the influence of frictional heat. As Fig. 10 shows, this must lead to serious difficulties at high Mach numbers.

For thermal reasons, therefore, the flying speed of ram-jet engines seems to find a limit at around Mach 3 to 4.

C. Rocket Engines

1. *Effective Efflux Velocity.* The range in unpowered gliding flight of a supersonic aircraft with lift/drag ratio ϵ and initial flying speed v_1, may be expressed in very good approximation by the relation :

$$s = -\frac{R}{2\epsilon} ln \left(1 - v_1^2/Rg\right) \approx \frac{v_1^2}{2\,\epsilon\, g}\left(1 + \frac{v_1^2}{2\,R\,g} + \frac{v_1^4}{3\,R^2\,g^2} + \frac{v_1^6}{4\,R^3\,g^3} + \dots\right)$$

whereby R signifies the radius of the earth (in metres). With $v_1 =$ 1,120 m/sec., the influence of the second term becomes greater than 1 per cent. of the first term ; with $v_1 = 3{,}290$ m/sec., the influence of the third term becomes more than 1 per cent. greater than that of the first, whilst the second term is already 8.6 per cent. of the first. At $v_1 = 7{,}900$ m/sec. the range, in view of the influence of the earth's curvature, becomes equal to infinity, instead of 20,000 kms. which the usual first term, not taking into account the supporting effect of the centrifugal force due to the curved trajectory of the aircraft following the surface of the earth, would furnish with $1/\epsilon = 6.4$.

Thus the range first increases as the second power and later as a quickly increasing power of the initial speed v_1, to become almost infinite at a value of v_1 of over 7,900 m/sec. ; this denotes that the trajectory takes on the character of a planetary path about the earth.

With a single-stage rocket engine, in which the weight drops from an original value G_0 to an end value G_1, and the ratio of the rocket thrust to the original weight is high, and for which the effective efflux velocity is c, a powered end flight speed, thus initial speed in gliding flight, v, of the magnitude :

$$v_1 = k\ c\ ln\ (G_0/G_1)$$

may be obtained, whereby $k < 1$ is a coefficient which takes into account the partial absorption of the thrust by air drag and by weight components lying at a tangent to the trajectory, and which itself only slightly depends on v_1 in the sense that it approaches unity as v_1 increases and, under favourably selected practical conditions, on the average can be estimated at about $k = 0.9$.

Consequently, the dependence of the range s on the effective efflux velocity c, for single-stage rocket engines, yields the formula :

$$s = -\frac{R}{2\epsilon} ln \left[1 - \frac{(kc)^2}{Rg} ln^2\, G_0/G_1\right] \approx \frac{(kc)^2 ln^2\, G_0/G_1}{2\,\epsilon\, g}\left(1 + \frac{(kc)^2 ln^2\, G_0/G_1}{2\,R\,g} + \frac{(kc)^4 ln^4\, G_0/G_1}{3\,R^2\,g^2} + \dots\right)$$

The range therefore begins by increasing as the second power, and later increases as a higher power of the effective efflux velocity, so that the latter's influence on the range is most apparent, being greater than that of the lift/drag ratio and for the most part greater than that of the mass ratio G_0/G_1 ; this circumstance is also evident from Fig. 12.

This justifies an effort to increase the effective efflux velocity at almost any price and, under given circumstances, even at the penalty of G_0/G_1 or ϵ.

As regards the definition of this highly important rocket index, it is odd that a very wide divergency of opinion still prevails.

We can, for instance, calculate this with an unvarying effective efflux velocity referred to absolute vacuum, which possesses the following characteristics.

According to Fig. 13, in a rocket-driven flying body, the unvarying effective thrust P is equal to the vector sum of all absolute gas pressures on the surfaces touched by the flame, thus the inner walls of the rocket, and the drag W is equal to the vector sum of all absolute pressures and tensions (in the metal, caused by frictional heat) on the outer surfaces exposed to the wind. The force available for accelerated or ascending flight is $K = P - W$.

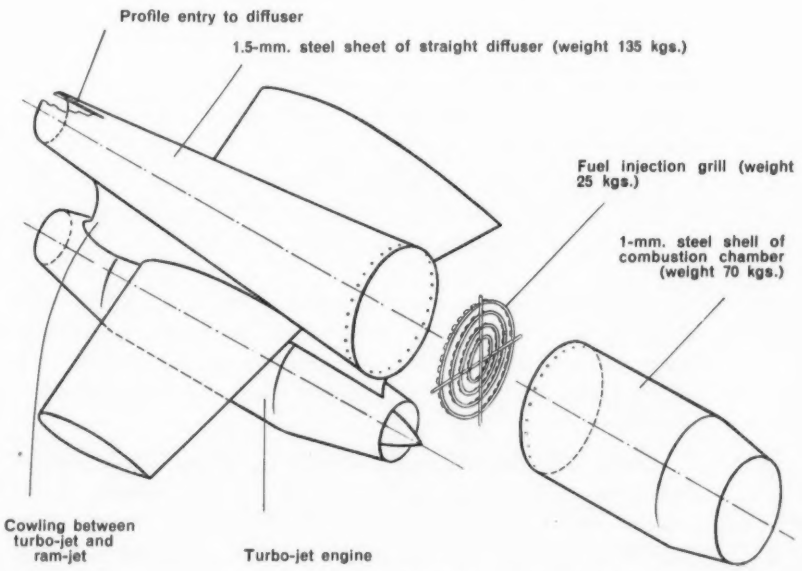

Profile entry to diffuser
1.5-mm. steel sheet of straight diffuser (weight 135 kgs.)
Fuel injection grill (weight 25 kgs.)
1-mm. steel shell of combustion chamber (weight 70 kgs.)
Cowling between turbo-jet and ram-jet
Turbo-jet engine

Fig. 8 : Main components of an experimental Lorin engine with oil heating, built on to a Messerschmitt Me 262.

Fig. 9: Interior of a high-temperature athodyd of 1.5-m. diameter, seen from the rear.

On the test stand or in the aircraft, a thrust dynamometer is used to measure the available thrust $P' = P - p_a f_m$, whereby p_a is the atmospheric pressure.

In the wind tunnel or in free flight, the smaller drag $W' = W - p' f_m$ is measured on the unpowered aircraft, whereby p' is the absolute air pressure downstream of the nozzle cross-section f_m. Hence these two forces cannot be used for equilibrium of the aircraft until a correction has been made: $K = P - W = P' - W' + f_m (p_a - p')$. It would consequently not be practical to derive the effective efflux velocity, as below, from the thrust P':

$$C' = \frac{P'}{dm/dt} = Cm + \frac{(p_m - p_a) f_m}{dm/dt},$$

this also for the reason that this value contains no engine index, but depends on the surrounding atmosphere, the air pressure, and hence the weather, the altitude, and so forth. Preference is much rather given to its derivation from the unvarying effective thrust P:

$$c = \frac{p}{dm/dt} = c_m + \frac{p_m f_m}{dm/dt}$$

Meanwhile, however, this process involves a transfer of the inconvenient force $p_a f_m$ to the aerodynamical side, where it is likewise unfavourably placed.

Its numerical values are always superior to those of the speed of flow c_m of the gases in the nozzle outlet; in ordinary liquid-fuel rockets, the difference approaches 14 per cent.

2. *Rocket Fuels.* The most important means of attaining high efflux velocities consists in the choice of suitable fuels of high calorific value, the utilisation of high combustion pressures, and the best suited design of combustion chamber, flame tube and fuel feed system.

During the first development stage of rocket flight technique, the choice of fuels was cautiously restricted to compounds of low calorific value: for example, dilute alcohols (*e.g.* methanol), amines (*e.g.* hydrazine hydrate, aniline), vinyl ethers, etc., and as oxygen carriers, hydrogen peroxide, nitric acid, and, only exceptionally, liquid oxygen, were chosen; whereby sometimes quite incidental characteristics, such as the behaviour of the fuels as coolants, as boosters, etc., played a part in the selection; and the combustion temperatures were kept below 3,000° K., whilst the effective efflux velocity was little more than 2,000 m/sec.

The present development stage, from the fuel standpoint, is centred on hydrogen compounds of high calorific value (*e.g.*, hydrocarbons, gas oil, hydrogen), and liquid oxygen (eventually enriched with liquid ozone), whilst for special functions use was made of special materials, such as injected diethyl zinc for ignition, water or mercury, etc., for cooling. The combustion temperatures are in the vicinity of 4,000° K. and the efflux velocity between 3,000 and 4,000 m/sec.

In a later, third stage, development will surely involve the heating with atomic energy of masses of low molecular weight, such as water or hydrogen, so that very high efflux velocities can be anticipated at limited combustion temperatures, *e.g.*, over 10,000 m/sec. at 5,000° K., using hydrogen.

As regards the direct utilisation of atomic energy, with its particle velocities of 1.2×10^7 m/sec. in uranium nuclear fission, for instance, no technical solution is in immediate prospect.

3. *Combustion Chambers.* The mixture preparation and the heating of the gases take place in the rocket's combustion chamber.

In chemically-propelled rockets, the mixture preparation is an exceptionally complex sequence of physical and chemical processes, such as injection, jet breakdown, droplet formation, droplet heating, droplet evaporation, turbulent mixing, mixing by diffusion, ignition, combustion, adjustment to equilibrium of the combustion gases, etc., which are at present being thoroughly studied and which can be influenced to a certain degree by constructional features. The goal of these studies is not to find methods enabling very complete combustion to be obtained, as the completeness of the combustion, owing to the high temperatures and consequently high reaction rates, is in any case as high as the chemical equilibria in the combustion gas allow it to be, if the preparation is more or less adequate. Otherwise, the stationary combustion would run the risk of pulsating or dying out.

The object of the studies is far more to find methods enabling the smallest possible combustion chambers to be used, which is mostly coupled with fastest possible preparation.

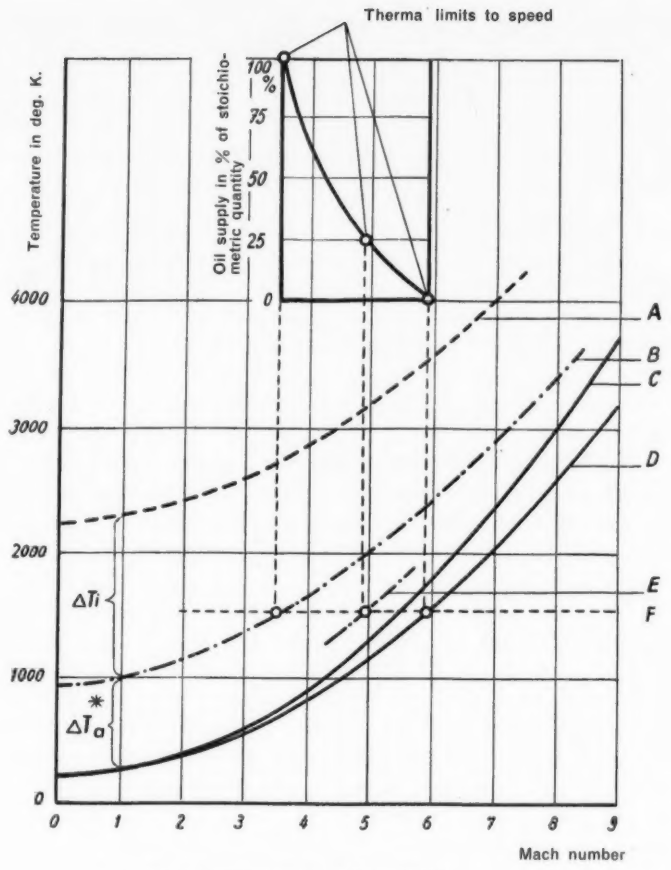
Time and space requirements for the combustion itself mostly give way completely to the corresponding requirements of mixture preparation.

We must begin by making a sharp distinction between single-phase liquid injection and multi-phase wet-vapour injection of the fuels.

In the case of single-phase injection, the desired fast breakdown of the jet is sought with special nozzle designs, *e.g.* perforated nozzles, slit nozzles, annular-slit nozzles, twist-injection nozzles, and so on. The theory of the twist-injection nozzles, for instance, reveals that the amount they inject and the angle of aperture of the jet cone are determined by the cross-section of the entry to the chambers, the accuracy with which this cross-section is centred, and by the cross-sectional area of the nozzle outlet.

These conditions make it possible to build a twist-injection nozzle which can be regulated within wide limits, and for which the size of the entry cross-section of the chamber can be controlled by very slight modification of the injection pressure.

The theory of the single-phase and multi-phase injection shows that, for the first type of jet, solely immediate impulse exchange takes place with the ambient medium mixed with it, whereas for the second type of injection, an immediate exchange of impulse and enthalpy occurs, thus enabling the wet-vapour droplets to complete their evaporation very quickly, and the ignition temperature of the fuels to be exceeded, whilst in the first case the droplets remain cold and unvaporised for a long time.



A = Flame temperature T_3 stoichiometric
B = Calculated wall temperature in a case of stoichiometric combustion of oil
E = ¼ stoichiometric combustion of oil
C = Compression temperature $T_2 = T_1 + \frac{v^2}{2{,}000}$
D = Frictional temperature $T_1 + \frac{v^2}{2{,}360}$
F = Temperature limit of high-temperature-stable steels
* = Wall temperature measurement.

Fig. 10: Limits of safe flying speed of athodyd in view of thermal requirements.

Both types of injection also differ from each other considerably as regards droplet formation, in so far as the single-phase jet furnishes much larger droplets through dynamic pulverisation, as a result of the equilibrium between surface tension and vapour pressure. These circumstances make it seem worth while to strive for artificial thermal pulverisation by addition of corresponding amounts of fuel.

Fig. 11: Tow test of a high-temperature athodyd of 1.5 mm. diameter and 10.6-m. length.

The heating of the droplets is achieved very quickly by convection only after thermal pulverisation, because the droplets then attain a size about equal to that of a molecule's mean free path, and owing to the very effective gas kinetic convection mechanism in mixture with burning gas, vaporise extremely quickly, whereas the convection in dynamically-pulverised droplets is only effective as long as they have not begun to boil. In the latter case, therefore, the only remaining method of heating is by radiation of combustion gas.

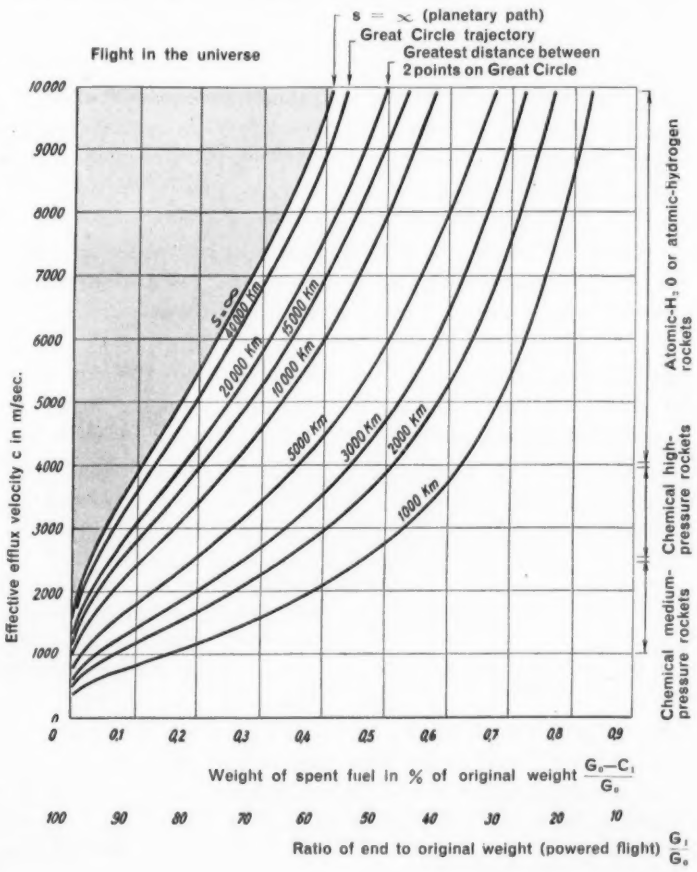
The theory of the three main components of the radiation of combustion gas, namely aerosol spraying, CO_2-H_2O radiation and chemiluminescent radiation, has been developed sufficiently to yield certain quantitative results of practical utility. The principles of the latter are based on the centimetre-wave reflection measurements of Gœrke on rocket combustion gases.

For very hot hydrocarbon combustion gases, grey aerosol radiation is of no significance owing to the lack of soot precipitation as a result of the replacement of CO_2 combustion by CO combustion after adjustment of the chemical equilibrium ; it is only of significance in cool combustion gases which disassociate poorly or contain metal.

The long-wave CO_2-H_2O radiation yields an intensity which amounts to fractions of the radiation of an equally hot black body, though this fraction is all the same very dependent on the temperature and the thickness of the layer of the radiated masses of gas ; in practice, it sometimes amounts to 15 per cent.

The short-wave chemiluminescent radiation (reaction luminescence) depends, as regards its total energy, solely on the heat toning of the reaction taking place. Its intensity, on the other hand, increases very quickly with the gas density and can be very much higher than that of an equally hot black body ; accordingly, however, its range decreases with the density.

Fig. 12: Glide trajectories s of rocket aircraft with single-stage rocket engines, versus fuel portion of original weight and versus effective efflux velocity c, for a lift/drag ratio $1/\epsilon = 6.4$ and a mean exploitation of 90 per cent. of thrust for acceleration.



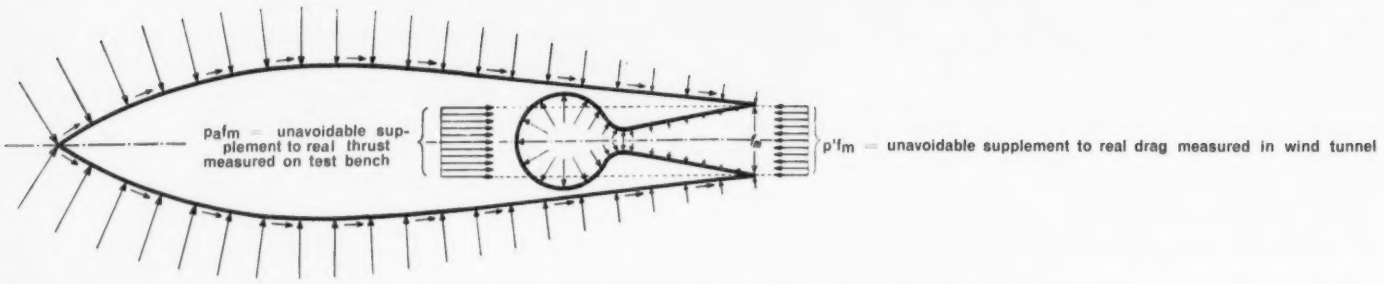

$p_a f_m$ = unavoidable supplement to real thrust measured on test bench
$p' f_m$ = unavoidable supplement to real drag measured in wind tunnel

Fig. 13: Inter-relation of drag and thrust when aircraft is in flight, with corresponding values measured on the ground.

In order to make the droplet-heating effective though radiation, it can become important, especially in the case of long-wave radiation of combustion gas, to suit the emission spectrum of the combustion gas to the absorption spectrum of the fuel by colouring the latter. Nevertheless, CO_2-H_2O radiation is coupled with very long heating durations, which, under suitable circumstances, can be considerably shortened by reaction luminescence.

Within the limits of the determinant time and space requirements, it is mostly the droplet vaporisation and mixture which take the longest time.

The droplet vaporisation can only proceed in a very short time if either the fuel is injected in two phases, *i.e.*, as wet vapour, because the convection is then very effective, or if the combustion temperature and density of the gases are so high that the reaction luminescence of the combustion becomes sufficiently intense to vaporise even mechanically pulverised droplets within the first fraction of a millimetre of their trajectory. (High-pressure rocket.)

The time and space requirements of the droplet vaporisation are therefore especially noticeable when fuels are injected in liquid form into burning gases of low density and moderate temperature, so that the heating should not be so much effected by convection or luminescence, but rather by the relatively weak but penetrant CO_2-H_2O radiation. (Low-pressure rockets, ram-jet engines.)

Only in this case is it necessary to attach particular value to very fine pulverisation, *e.g.*, by utilisation of twist-injection nozzles, multi-phase additions to the fuel, etc., and eventually by altering the absorption spectrum of the fuel. In cases of very luminescent reactive combustion gases, the fineness of the dynamic pulverisation is relatively unimportant. In conclusion, therefore, it is the mixture itself which as a rule fixes the time and space requirements.

The most effective way of favouring it is by means of very extensive primary macro-mixing, thus by injecting the fuel through a great number of very small and very well distributed nozzles.

The mixing process is further improved by the droplet jets of the secondary macro-mixture, which cross each other ; furthermore by the turbulence of the gaseous stream components, finally to be completed by diffusion (effective over only very short distances).

These measures make it seem possible that the present usual ratio of combustion chamber volume to narrowest outlet cross-section, amounting to three metres in rocket and jet engines, will be cut down considerably, perhaps to a fraction of a metre.

The mixture preparation requires a finite period of time, which one must make available to the fuels in the form of their storage life in the combustion chamber. For this ratio of the combustion chamber volume V_0 to the volume of the combustion gases passing through per second, the following expression is obtained :

$$t = \frac{V_0}{f'} \sqrt{\frac{\left(\frac{\kappa+1}{2}\right)^{\frac{\kappa+1}{\kappa-1}}}{\kappa\, g\, R\, T_0}}$$

whereby f' is the narrowest outlet cross-section, *e.g.*, the cross-section of the neck of the nozzle, and κ, R, T, time mean values of adiabatic exponents, gas constants and temperature of the gases in the combustion chamber. Hence, with the same fuels and the same degree of combustion, the storage life is primarily dependent on the ratio of the volume of the combustion chamber to the cross-section of the neck of the nozzle, whereas the actual shape of the combustion chamber, and the combustion pressure, are largely without significance.

In the case of the liquid-fuel rockets manufactured in Germany, V_0/f' was always in the vicinity of three metres, which, under the combustion gas conditions prevailing at the time, would correspond to a storage life t of approximately 10^{-2} sec.

As practical experience has shown, this duration, in a case of intense macro-mixture, is sufficient for mixture preparation and complete combustion.

In the case of atomic rockets, too, a corresponding time for preparation and consequently a corresponding size of combustion chamber will be necessary.

Noteworthy is that this figure, $V_0/f' = 3$ metres, has so far proven its utility in flight tests, as the lower limit value of the volume of the combustion chambers of ram-jet engines and resonance ducts, provided the macro-mixture was well advanced. Closer investigation of the preparation processes, however, reveals that there are important cases where the requisite combustion chamber volume is less defined by the narrowest outlet cross-section of the flame tube — roughly in the form of $V_0 = 3\, f'$ — than by the distance d from each other of the injection nozzles — roughly in the form of $V_0 = 2.5\, \pi\, d^3$ — so that the combustion chambers of rockets and ram-jet engines can become considerably smaller with d and, within certain limits, the principle of geometrical similarity can be applied in the construction of scale models.

Continued in the next issue

NUCLEAR ENERGY FOR AIRCRAFT PROPULSION

Possibilities and Prospects

In the section on aeronautical research, the report on U.S. rearmament in the air published at the beginning of this year by the Presidential Air Policy Commission, stated, among other things, that immediate steps should be taken to intensify research on the employment of atomic energy for the propulsion of aircraft.

At the time this statement was made, the NEPA Project (NEPA meaning Nuclear Energy for Propulsion of Aircraft) had been proceeding at Oak Ridge for over a year, so that a certain amount of clarity must reign in connection with the fundamental prospects of the idea. It is also to be assumed that the knowledge gained up to that time was sufficient to justify continuation of the project.

As far as the public is concerned, and also aviation circles, the idea of using nuclear energy for propelling aircraft is generally taken little notice of, or regarded with scepticism. Apart from the fact that no indication has so far been given on the path being taken, the domain of nuclear physics is rather foreign to aeronautical people, so that it is not easy for them to acquire a proper idea of the possibilities and prospects of atomic energy as a propellant for aircraft. Basing their judgment on the scanty information released on projected atomic power stations, the majority cast aside the idea as being purely Utopian. Here and there, however, there crops up an assertion that flight on nuclear power could become reality in a very short time.

Both opinions would appear to be erroneous. Just as it is illogical to make a comparison between a stationary power station and a light-weight aero engine, it is useless to attempt to derive, from plans for stationary atomic power stations, data on how nuclear power plants for aircraft should look and work. Neither should it be forgotten how long it took from the day the steam engine was invented until a light, reliable combustion engine could be built. Indeed, the technique of harnessing atomic energy is today no more advanced than the technique of building steam engines was in the days of James Watt.

What would be the characteristics of an engine driven by atomic energy, suitable for installation in aircraft ? In answering this question, one must realise that the present stage of development provides for utilisable atomic energy only in the form of heat. Whether it will one day be possible directly to gain electrical energy, remains to be seen, and is not especially important to aeronautics.

Heat is a form of energy which can be converted into kinetic energy either through the medium of steam production (steam engine or steam turbine) or hot and highly-expanded gases (combustion engine, gas turbine or ram-jet). Steam engines, which would seem to offer the simplest means of exploiting atomic energy, could obviously not be used in conjunction with aircraft. The particular way in which nuclear fission furnishes heat, moreover, precludes application of the principles of the reciprocating engine. Judging on the basis of present-day knowledge in this domain, it would seem, therefore, that nuclear power units for aircraft would have to embody the principles of the gas or hot air turbine and of the ram-jet engine.

As is known, atomic energy is derived from the fission of nuclei, with a controlled chain reaction. Fissionable elements, such as the U 235 isotype of uranium or the Pu 239 isotype of plutonium, or better said their nuclei, take on escaping neutrons during the actual chain reaction and decompose into fragments as a result of instability. Together, these fragments have a smaller mass than the original nuclei. The disappearance of the mass gives rise to a release of energy in the form of radiation and heat. One can imagine the latter as arising through atomic friction, caused by the collision between disintegrating nuclear fragments and other nuclei. The heat, produced in a continuous stream inside the " atomic fuel, " must be transmitted by means of a heat carrier (coolant) in order that it may be converted into kinetic energy by a machine. If a gas is used as heat carrier, then the most logical means for converting the heat into kinetic energy is through cooling and contraction in a turbine or a duct.

Here, however, the problem gets " hot " in the truest sense of the word. Technically and constructionally, it calls for a pile through which, for example, a neutral gas or air is pumped. Accompanied by an increase in pressure, this causes a transmission of heat throughout the gas (energy transmission) and subsequently, in a turbine or a ram-jet duct, the usual heat release and contraction (energy absorbance). In this process, however, it is unavoidable that not only the constructional materials of the pile and the heat carrier, but also all other machine parts, will become more or less strongly radioactive under the effect of the intense nuclear radiation. This means that an engine consisting of a pile and a heat converter, which is or has been operative, may not be touched by humans for the purpose of regulation or re-starting, and for a long time may not even be inspected from close proximity.

A limitation of this sort is of course unthinkable with respect to an aircraft. It would be least unbearable in conjunction with a ram-jet, which features no moving parts and therefore requires little maintenance. Hence, a ram-jet fed with atomic heat would seem to be the simplest and most likely attainable form of nuclear power plant for aircraft.

Among the multitude of technical and physical problems connected with the development of nuclear power plants for aircraft, which have not yet or only in part been solved, we shall restrict ourselves here to only a few of the most important ones.

The atomic fuel, that is to say the fissionable original product, with which the stationary atomic power station of the future will be fed, is primarily pure uranium. In order to establish a chain reaction after fission of its U 235 isotype, which is the sole fissionable isotype and is only contained to an extent of 0.7 per cent. in uranium, rather large quantities are necessary. Besides this, it is also necessary to have considerable quantities of graphite, which serves as a tamper to cut down the speed of the neutrons. For reasons of weight alone, an uranium pile could not be used for aeronautical purposes. More favourable possibilities, however, are presented by plutonium, which represents a concentrated source of atomic energy and does not require any additional tamper. The slow and controlled chain reaction of plutonium has already been realised. Another concentrated but very expensive source of atomic energy is represented by the U 235 isotype, and there is no reason not to expect that the future will provide further fissionable substances featuring perhaps still better qualities. At all events, it should be possible one day to harness the destructive effect of the detonation of a few kilogrammes of fissionable material and follow it up with a controlled chain reaction allowing for an adjustable production of energy. It is also conceivable that the weight factor may be kept within reasonable limits.

The main technical difficulty is presented by the dangerous radioactivity, fatal to living organism and also detrimental to many constructional materials. Nuclear fission and the production of atomic energy is

indivisibly coupled with strong particle radiation (alpha, beta, and neutron rays), as well as the extremely dangerous electromagnetic gamma radiation. Of these, the alpha and beta particles are relatively harmless, and can be screened off by fairly light materials. Their effect is quickly weakened after a short passage through air, and further screening can be effected by aluminium, thus a very light-weight constructional material. The positioning of nuclear engines well towards the tips of the wings would, in the case of large aircraft, afford adequate protection to crew and passengers. The neutron rays, however, offer great difficulties since many constructional materials brought into contact with them can become radioactive, and their effect on living organism is extremely damaging. But there exist materials, for instance cadmium or boron, which are not too heavy and reflect them without absorbing them.

The most serious difficulty of all, however, is presented by the short-wave gamma rays, whose intensity, in view of their deadly effect on living organism, must absolutely be kept within limits. The bearable amount of radiation which a human can support in a day is estimated at 0.1 x-units per eight hours. This corresponds to the radiation of 1/50 grammes of radium, or 3,300 gamma rays per square centimetre of 2 million electron volts (2 MEV). Gamma radiation is so penetrant that a quantum of 2 MEV is subjected to a reduction of 10 : 1 only after travelling 400 metres through air or penetrating a lead wall of 4.5 centimetres in thickness. (An electron containing the same amount of energy is weakened to the same extent after it has travelled seven metres through air or penetrated through three millimetres of aluminium.) The radiation produced by nuclear fission, however, concerns many million x-units and a radiation which contains many times more energy than that from radium.

Under these circumstances, there is no other means of screening off nuclear power plants than with thick and heavy plates of lead. Meanwhile, in the special case of aircraft, an alleviation of these conditions is provided insofar that the power units can be positioned some distance from the fuselage and only a small area of them, and not on all sides, need be screened off. The greater part of the destructive radiation, together with the hot air stream which would by then have become radioactive, would be ejected through the tailpipe into the atmosphere, whereby this would all the same give to a strongly-ionised and radioactive wake. This gives birth to special problems as regards the " poisoning " of the air space and the utilisation of radio equipment. Apart from such disadvantages, however, it remains for the future to show whether it will be possible to keep the weight of nuclear power plants and their screening media within bearable limits.

To sum matters up, it is clear that the possibility of using atomic energy for the propulsion of aircraft is not to be ignored. If the U.S. Atomic Energy Commission estimates that ten years will be required for developing the much more simple nuclear steam engine to the point of practical utility, then the project for using nuclear energy as a propellant for aircraft will probably require at least as long for its first development stage. There are reasons to suppose that atomic energy will only be utilisable for very big aircraft, since chain reactions in conjunction with the fissionable elements known so far, cannot take place unless the element is in sufficient quantity, thus requiring a large-size pile. Whether it will be possible to attain reasonable operating costs depends on research results and on improvements in the methods for gaining fissionable substances.

The surmounting of the enormous difficulties which are coupled with the project for applying nuclear energy to the aircraft propulsion field, would doubtlessly be worth while if it were successful. For it would represent a big step forward in aeronautical science : with a few kilogrammes of fissionable substance, even though the power plant might have to weigh a number of tons, it would be possible for large aircraft to be propelled at high speed over practically unlimited distances—and perhaps even at supersonic speed. It is hardly necessary to emphasise what that would signify.

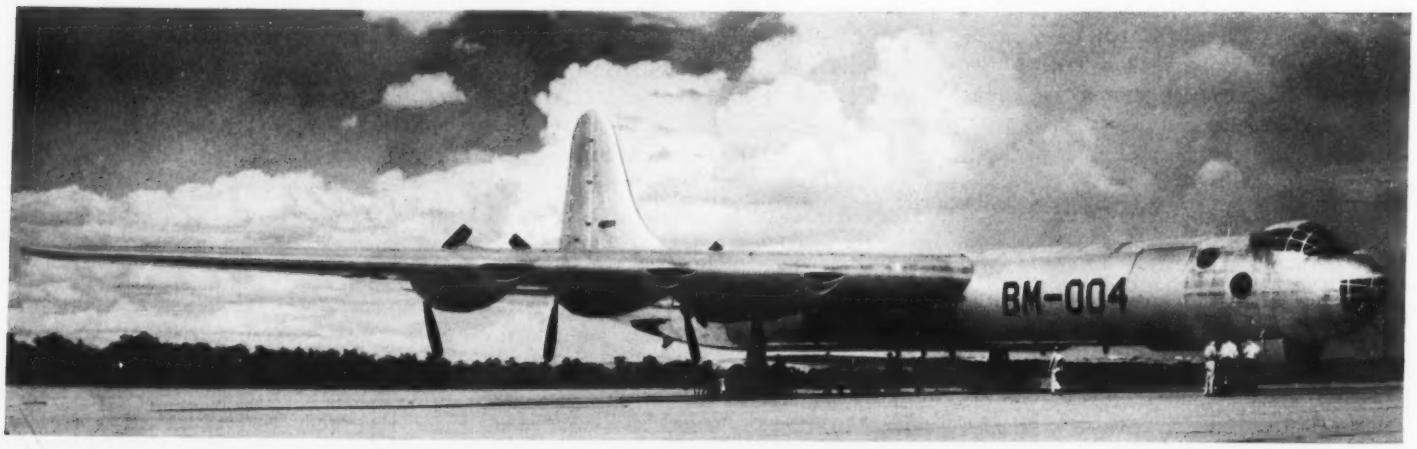
S.

Production-Model Convair B-36

The famed Consolidated-Vultee B-36 long-range bomber, of which over 50 units are in production, has been subjected to a number of modifications since the tests with the XB-36 and YB-36 experimental models.

The chief modification involved replacement of the two massive 110-inch main landing wheels with eight comparatively small wheels, arranged in four-wheel trucks. Chiefly resulting in safer take-off and landing runs, the eight 56-inch wheels, fitted with extra-high-pressure tyres, provide a more effective distribution of the big bomber's 139-ton gross weight. Besides enabling a weight saving of 2,600 lbs. to be effected, this arrangement also makes tyre servicing simpler and, in all likelihood, cheaper. The aircraft can now utilise a greater number of airfields than previously, since the new multi-wheel gear subjects runways to smaller stresses and the additional brake drums help to shorten landing runs. Another aid to shorter landing runs is, of course, also made possible by the reversible-pitch propellers. Last but not least is the additional safety : a blow-out of one of the eight small tyres would be far less critical than a blow-out of one of the two huge tyres.

Another modification to the production model B-36 concerns the new nose configuration, where a bubble canopy and side windows have been provided, presumably to improve vision for pilots and gunners. Silence continues to prevail as regards the big bomber's armament. Even the indicated range of 10,000 miles remains vague. On the other hand, however, it is stated that a test flight of over thirty hours was made between Fort Worth, Texas, and the U.S. West Coast.



The Greene Stall Warning Indicator

By William WINTER, Cornwall Bridge, Conn.

When an early-bird pilot discovered the solution to the once-dreaded " tail spin " by putting the stick forward " because he was a goner anyway ," supposedly the last great basic mystery of flight had been solved. But that we have been living with an equally great mystery is indicated by a young man named Leonard Greene, who refused to believe that man could fly " by the seat of his pants."

Consider the fact that more than half of the fatalities in private flying result from inadvertent stalls and spins from low altitude. Then also consider that the development of a practical stall warning indicator has, until now, defied the finest aeronautical brains. Young Doctor Greene's invention of a simple, low-cost, fool-proof stall warning device that works under all flight conditions and all attitudes of the aircraft, is a most welcome if not a revolutionary development.

Whereas most previous stall warning indicators operated according to changes in airspeed, Greene's functions because the separation of air flow in front of a wing creates a " stagnation point " close to the leading edge. This stagnation point moves downward in respect to the leading edge of the wing whenever a stall is approached. A metal tab protrudes through the leading edge at a 60 deg. downward angle, so that the normal flow of air will hold the tab against a stop (Fig. 1). When the stagnation point shifts, the flow of air past the tab is reversed. This deflects the tab (Fig. 2), closing an electrical circuit that sounds a warning buzzer and flashes a red light in the cockpit (Figs. 3 and 4). The device therefore gives accurate warning, regardless of the position of the aircraft, condition of flight, size or shape of the wing, or thickness of the aerofoil. On a Fairchild F-24, for example, the device may operate at 55 m.p.h. in a stall from level flight, but also will show the stall at 94 m.p.h. in a steep, tight turn.

Consisting of two units—the wing unit and the cockpit unit—the Greene stall warning indicator weighs 11 ounces, costs $47 and can be installed by any aircraft and engine mechanic. The wing vane is connected to an electrical relay inside the wing, which opens or closes the electrical circuit to the instrument itself. A 1¾-inch round hole in the leading edge accommodates the tab unit ; after installation the hole is covered with a slotted metal plate. The panel unit is a small Bakelite box that fits into a standard 2¼-inch hole. In the centre of the face of the box is the red warning light and inside the box is the warning horn. Operating on a 12-volt electrical system—two 6-volt batteries last for six months when the plane is not equipped with such a system—the tab is mounted at about one-third the distance spanwise towards the wing tip, or beyond the propeller slipstream. It can be adjusted to give a warning at, say, five or ten miles per hour before the stall, and will give this percentage of warning under all flight and operating conditions, flaps and wheels up or down. Approximately 110 per cent. of the stall speed is considered the ideal warning.

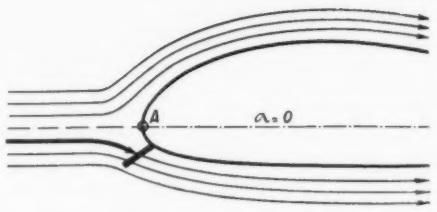


Fig. 1: At small angles of incidence, the air flow stagnation point (A) is always over the stalt warning indicator's metal tab, thus holding il against a stop. As the angle of incidence increases, A shifts further downwards.

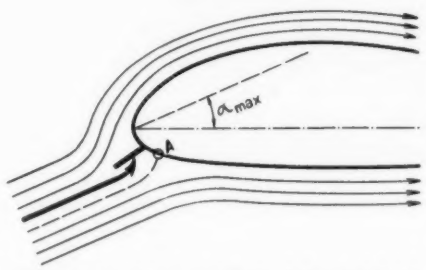


Fig. 2: A correct arrangement of the metal tab causes the stagnation point to be beneath the tab already before the critical angle of incidence is reached. The vane is then deflected upwards and the various warnings are given.

Since the deflection of the tab depends on movement of the stagnant air point at the leading edge, the device is always off when the plane is on the ground. The instrument cannot be shut off by hand, which precludes the possibility of overlooking the indicator on take-off. A temporary-disconnect button enables an instructor to keep the instrument inoperative as long as pressure is maintained on the button.

Mass tests have demonstrated that pilots cannot accurately detect a stall when intentionally approached, but they inadvertently approach stalls on occasion in routine flying. In consequence, a number of powerful groups have recommended that the stall warning indicator be mandatory on all private aircraft. Last autumn, the Non-Scheduled Flying Advisory Committee of the Civil Aeronautics Administration recommended unanimously that stall warning indicators be made standard equipment, and that spin tests for applicants be dropped on all aircraft with such devices. The National Aviation Clinic passed a Bill of Policy recommending universal use of stall warning devices. A CAA report recommends standard use of stall instruments. The Stinson Division of Consolidated Vultee Aircraft Corp., whose 165-H.P. " Voyager " and " Flying Station Wagon " are noted for stability and high resistance to spins, has standardised on Greene's indicator and the mother company is equipping the " Convair-Liner " with it. Leading insurance companies grant reductions in premium when stall warning indicators are installed, and even crop-dusting machines may be insured with the addition of that instrument.

Fig. 3: The metal vane and the electrical relays for the warning circuit are contained in the leading edge of the port wing. The entire installation can be made from outside the wing through a small hole cut in the leading edge.

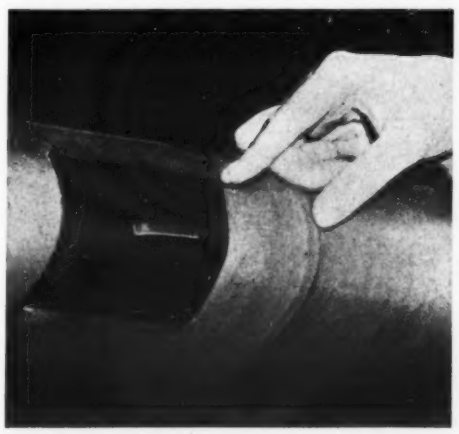


Fig. 4: Deflection of the tab closes an electrical circuit that sounds a warning buzzer and flashes a red light in the cockpit.

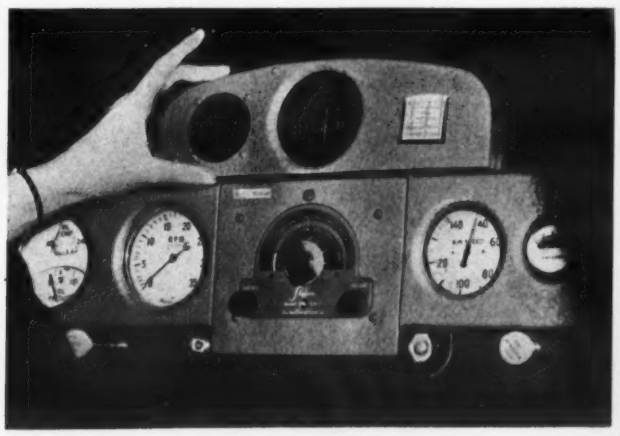


Fig. 5: An Aeronca "Champion" fitted with five stall warning indicators, so adjusted that five separate warnings are given progressively as the stall is approached.

The Greene device recently figured in one of the most interesting large-scale pilot-ability tests ever conducted. With CAA funds, the Educational Research Cooperation, of Cambridge, Mass., made an exhaustive study of the accuracy of recognition of the incipient stall in familiar and unfamiliar aircraft. Two-hundred-and-sixty-four pilots were investigated (93 students, 90 private pilots, and 81 flight instructors) on the familiar plane, an Aeronca "Champion," and 119 (39 students, 44 private pilots, and 36 instructors) on the unfamiliar type, a Taylorcraft L2M. Each aircraft was equipped with five stall warning devices, so adjusted that five separate warnings would be given progressively as the stall was approached (Fig. 5). Each indicator was connected with a light on a panel held in the check pilot's lap. The panel itself was not visible to the subject, and the warning horn was inoperative.

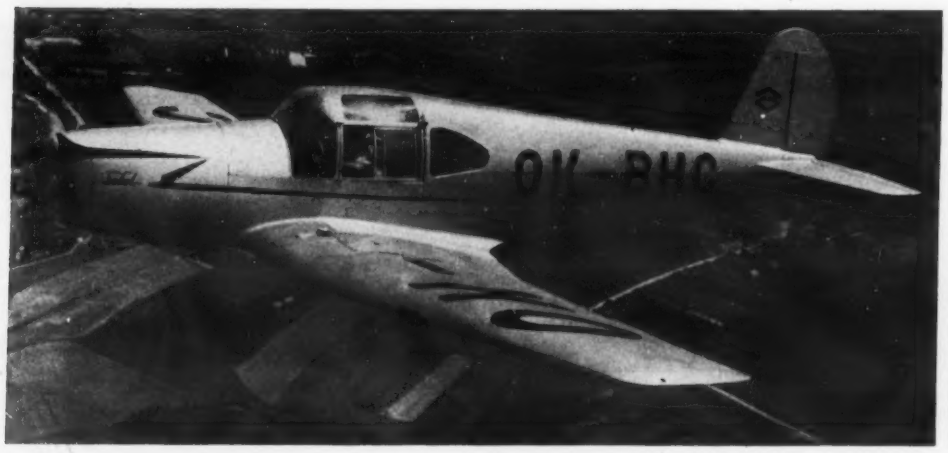
All subjects were requested to perform the usual sequence of test manœuvres, approaching the stall as closely as possible, but not actually stalling the aircraft. In their intended approaches to a stall in the familiar machine, 15 instructors actuated but one light, and another 53 but two lights. This ragged performance was a surprise, particularly since all pilots had a minimum of 75 hours on the same type of plane during the previous 90 days. Eighteen students and private pilots showed no lights during the intentional stall approach, 46 one light, and the majority, two or more lights; 79 pilots (only three instructors, however) actually stalled the aircraft. The report stated gloomily: "It appears that even with the familiar plane in a familiar manœuvre, in which the stall is familiarly practiced and included as a standard part of the flight curriculum of the CAA, pilots do not know where the stall occurs."

The general check of all these pilots' reactions in routine flying revealed that a few pilots actually came closer to the stall inadvertently than they would intentionally. The report therefore concluded: "Pilots do occasionally approach the stall inadvertently and do frequently fly in such a manner that their deviation from normal is in the direction of an approach to a stall." CAA accident statistics do, as a matter of fact, indicate that in all of these it is the man with the most hours who most frequently commits the fatal *faux pas*, presumably because such pilots habitually fly closer "to the edge."

In many cases, however, pilots will find this indicator helpful in, say, an abortive landing, where the flaps and landing gear may have to be retracted as the machine slowly gains airspeed in "going round again," or where a slow approach is made over obstacles into a small field. The general feeling is that the stall warning indicator enables the pilot to get more out of his machine. At all events, at the time of writing none of the several thousand aircraft so far equipped with the Greene stall warning indicator has been involved in a stall and/or spin accident.

SOKOL M1C

The Sokol M1C personal aircraft is a product of the Chocen firm, which is part of the Czechoslovak nationalised automobile manufacturing group. Representing the latest link of a whole development chain, it is of wooden construction like its predecessors and is remarkable for its small gross weight of 1,700 lbs. The three-section wing, spanning 32 feet 9½ inches, has two spars and a plywood-skinned leading edge, whereas the remainder of the wing is fabric-covered. Between them, the ailerons and flaps extend over the entire span. The fuselage, 24 feet 1½ inches long and plywood-skinned throughout, encloses a roomy cabin offering accommodation for two passengers in addition to the pilot. The fixed control surfaces of the simple, cantilever empennage form a unit with the fuselage and are plywood-covered; the movable surfaces are covered with fabric. Like most of the modern personal aircraft, the Sokol M1C has a retractable undercarriage. A Walter Minor 4-III four-cylinder in-line engine, delivering 105 H.P. at 2,500 r.p.m., endows the aircraft with a maximum speed of 150 m.p.h. and a cruising speed of 130 m.p.h. Service ceiling is 15,750 feet and maximum range 620 miles.



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Scandinavian Airlines System

Mr. Per A. Norlin, President of SAS and author of this article.

BY PER A. NORLIN, STOCKHOLM.

Day was breaking as a group of weary but satisfied men pushed back their chairs from a conference table in the Grand Hotel, Oslo. It was August 1st, 1946. They were weary because, for eighteen hours, they had been sitting in conference without a break. They were satisfied because they had finally reached a measure of agreement for that co-operation which was soon to become known as Scandinavian Airlines System.

Great as the satisfaction of these representatives of Scandinavian aviation may have been, none of them could have foreseen, on that early August morning, that in less than two years the organisation they had shaped for intercontinental aviation would become mature enough to be extended to all scheduled Scandinavian air services. Still, that is what happened; and it has now been proved to the world that reason, good will and mutual confidence can overcome national prejudices and short-sighted egoism.

Even before the war, the Scandinavian countries had negotiated for a common airline to North America. Plans were under way when war broke out in 1939, and at the beginning of 1940 negotiations between the Scandinavian postal authorities, the airlines and the American authorities had progressed so far that it was hoped to start a line in co-operation with Pan American Airways. But the invasion of Norway and Denmark put an end to these plans. Nevertheless it was not long before the subject came up again. AB. Aerotransport, which had been the driving power behind the earlier plans for setting up joint Atlantic operations, resumed its efforts to prepare such a joint line for the future, not only for its own sake but for its Danish and Norwegian colleagues. Needing appreciably more capital, ABA applied to the State for assistance. The Swedish government, however, was not interested, under the conditions prevailing at that time, in backing the project financially, and was of the opinion that private enterprise alone should shoulder the risks. And so, after prolonged negotiations between the government, ABA and private interests, Swedish Intercontinental Airlines (SILA) was formed to operate all Swedish intercontinental air traffic. A simultaneous agreement with ABA assigned all European operations to this state-owned company and all intercontinental services to SILA. To avoid wasteful duplication, ABA placed its technical and administrative facilities at SILA's disposal.

Mr. Thomas S. Falck, Jr., head of the Norwegian DNL company, who is now Chairman of the Board of SAS.

Thus it was SILA which, with ABA's consent, resumed the plans for Scandinavian co-operation in the air. Despite the obvious difficulties facing international conferences during the war years, negotiations were immediately started with the Danish and Norwegian airlines, with both Occupied Norway and the Norwegian government in London represented. Detailed planning was impossible under the circumstances, but all agreed that Scandinavian co-operation was desirable and that aircraft should be ordered in readiness for an early start when the war was over. SILA also conducted negotiations in America for the Danish and Norwegian companies. And as early as November, 1943, a contract was signed with the Douglas Aircraft Company for the first postwar "Skymasters." An air agreement was signed between the Scandinavian countries and the U.S.A., so that when the war came to an end, operations could begin immediately. Beforehand, the U.S. government had very generously placed at the disposal of the Swedes a number of B-17's forced down in Sweden. During the period of transition, before the new material could be delivered, these planes were used for special flights to North America and for training crews. In June, 1945, immediately after the end of the war in Europe, the first special flight was made.

Vice-Chairman of SAS is Mr. Marcus Wallenberg, of the Swedish SILA company.

Negotiations with Denmark and Norway now made new headway. But though the principle of co-operation was accepted by all, it was no easy matter to find a suitable pattern for co-operation. There had been no opportunity during the war, in Denmark or in Norway, as there had been in Sweden, for building up an organisation and recruiting and training personnel. Thus the three parties were not equally well prepared for the task. But in spite of this inequality, opinion was unanimous that co-ordination was necessary if Scandinavian aviation was to hold its own in the field of international competition.

Passengers board a DC-6 of SAS in New York.

The agreement which was finally reached on the morning of August 1st, 1946, has since proved satisfactory to all parties. The greatest difficulty was still to find the most suitable pattern for co-operation. It was clear that there could be no question of setting up a corporation, since such a body would have to be registered as either Danish, Norwegian or Swedish. The enterprise had to be a common Scandinavian one, not bound to the laws of any one of the three countries. The problem was solved by forming a consortium, in which the three founder companies—Det Danske Luftfartselskab (DDL), Det Norske Luftfartselskap (DNL) and Svensk Interkontinental Lufttrafik AB. (SILA)—participated in the proportion of Sweden 3/7, Norway 2/7 and Denmark 2/7, which corresponded roughly to the individual resources of the three countries. Thus SAS is not a native of any of the three countries ; it is a true Scandinavian air union. It started regular services linking Scandinavia with North and South America, and the revenue and expenses were divided among the three companies according to their respective holdings in the consortium. And in the same proportion, each company contributed aircraft and the necessary working capital. The founder companies charter their planes to SAS, which, however, has its own organisation with head office in Stockholm, and its own flight personnel, recruited mainly from the three Scandinavian countries.

SAS is headed by a six-man Board of Directors, with two Danish, two Norwegian and two Swedish members. Chairmanship, changing each year, is held in turn by a representative of one of those countries. The first Chairman of the Board was the Director of DDL, Mr. Per Kampmann. This year the office is held by the head of the Norwegian DNL company, Mr. Thomas Falck, Jr., and in 1949, the present Vice-Chairman, Mr. Marcus Wallenberg of Sweden, will be elected.

Mr. Per Kampmann, Director of DDL, was the first Chairman of SAS (in 1947).

Of the three original members of SAS, the Danish DDL company is the oldest. It has a capital of thirty million Danish crowns, of which 17 per cent. are State owned. SILA, controlled entirely by private interests, is capitalised at twenty-four million Swedish crowns. Although at the start SAS had largely to depend on ABA's proven technical organisation, ABA did not become a partner in SAS but continued to build up its European network according to the agreement with SILA. DNL's capital is twenty-five million Norwegian crowns, 20 per cent. being State-owned.

* * *

The highways of the air are unfortunately not as free as those of the seas. In spite of many international conferences, general agreement on the five freedoms of the air for scheduled commercial aviation has not been reached. The three Scandinavian countries, however, have jointly, and successfully, negotiated bilateral agreements, giving SAS extensive traffic concessions. In some cases these concessions have been granted not to individual founder companies but to the Scandinavian combine, which has thus won official recognition by foreign powers.

Many of the foreign companies with which SAS has to compete on the Atlantic routes are government-subsidised in one way or another, mainly because it is considered of vital importance for the nations concerned, to maintain air communications with colonies, dominions, and economic spheres of interest overseas. This makes a more rational and economical organisation imperative for a predominantly private concern such as SAS, which has to meet foreign competition without being backed by government subsidies. Co-operation between the three companies on the intercontinental routes meant a substantial saving in overhead costs. But even more important, it was not likely that it would pay to carry on operations on a smaller scale than SAS does, and none of the three Scandinavian countries alone could count on enough passengers or cargo for a daily trans-Atlantic service.

* * *

Since co-operation on intercontinental routes had proved so successful, it seemed foolish that the three national airlines should continue competing within Europe. DDL and DNL had not been competing with SILA, which had not operated on the continent ; but they had run in competition with ABA which had concentrated all its forces within Europe and not joined the consortium. Each company had its own offices in the chief continental

cities, trying to draw passengers for itself. SAS passengers, who had seen the three small countries successfully working together outside Europe, were amazed to find that when the plane landed in Europe this co-operation came to an abrupt end.

It was therefore natural that the national airlines should also seek a co-operative working plan for European and inter-Scandinavian traffic. Their task became easier once the problem of merging the two Swedish companies, ABA and SILA, was solved satisfactorily. On July 1st, 1948, SILA merged with ABA ; and in the new ABA, State and private interests hold equal shares. The terms of the merger ensure a businesslike management of the new company, which replaces SILA in SAS, thus making it possible to extend co-operation between the Scandinavian airlines to the European field of operations.

* * *

General trends in world avaition have helped to accelerate this move. Air traffic has developed rapidly since the war, but not always as we might have wished. Operating new aircraft proved more expensive than estimated, and delivery delays created unforeseen difficulties for the carriers. Although the number of passengers has increased rapidly, it has not yet come up to expectations. Travel and trade restrictions, and the political situation in general, do not seem to indicate that better times are just around the corner. The general rise in costs, combined with a declining traffic frequency and rates which are too low, have placed great difficulties in the way of many airline companies, which they are trying to overcome by cancelling orders for aircraft, streamlining their organisations and intensifying their sales campaigns.

In an aim to strengthen their position, to utilise their flying equipment more economically, and to satisfy the transportation demands of the three Scandinavian countries more efficiently, the airlines took the final step towards co-ordination of their activities in all fields. While traffic outside Europe demands special consideration, already met by the original SAS central organisation, within Europe the three companies continue to exist as independent units, although all traffic plans, traffic

Miss Denmark, Miss Norway, Miss Sweden : SAS stewardesses.

handling, technical supervision and so forth, are co-ordinated under the name of SAS. Detailed plans for common foreign representation, common operations, common technical services and a common accounting system have been worked out by special sub-committees. The planes of the three companies flying the European network will be decorated in the same way as the original intercontinental planes, that is, with the "Viking Dragon" and the coats of arms of the three nations. Scheduled European services are directed by a co-ordination office in Copenhagen, and a freight centre in Oslo will supervise charter flights. The joint SAS fleet numbers 89 aircraft, including 17 DC-6's, nine DC-4's, 39 DC-3's, four Vickers "Vikings" and three Short "Sandringham Mark VI" flying-boats. Four Boeing "Stratocruisers" and ten SAAB "Scandias" will be delivered during 1949.

Copenhagen became the maintenance base for the SAS DC-4's at the end of 1947. Oslo will take over maintenance of twin-engined aircraft, while Stockholm will become the base for DC-6's and "Stratocruisers."

The total network of SAS, over which joint operations were begun on April 18th, 1948, covers 92,603 miles, linking 69 different towns in Europe, Africa, the Middle East, North and South America. It has taken several years to realise the idea of a federation of the Scandinavian airlines. In spite of the last world war and its aftermath, this federation is now a well-established fact. The pioneer work of building up the organisation of the intercontinental SAS was accomplished in less than two years. The first steps towards including the European routes in the system have been taken this year, but it will probably take another one or two years before the combine takes definite shape. Meanwhile, SAS is busily trimming its sails, and its leaders are confident that by combining efforts and creating an efficient organisation, they will be able to make aviation a paying proposition.

Crew of a trans-Atlantic DC-4, all of whom speak English and either Danish, Norwegian or Swedish.

Reminiscing at Rhein-Main

It was on a dull Autumn day in 1945, as a mobile crane of the U.S. Army drove up to the administration building of Rhein-Main air base, Frankfurt. Its powerful steel claws made for the top of a high granite column, grabbing an eagle and a swastika which were destined to end up in the smelting pot.

On an early summer's day in 1948, a cotton covering fell from the same granite column, unveiling a globe of ten feet in diameter, with jet aircraft encircling it at the equator, and a bronze dove, weighing about a hundred-and-fifty pounds, perched at the North Pole. Before a crowd consisting mainly of G.I.'s, the Mayor of Frankfurt dedicated the "International Civil Aviation Symbol" of Rhein-Main airport.

* * *

The history of German civil aviation, of which the end was underlined by these symbolic procedures, was short-lived. The first air route certificate, granted to the "Deutsche Luftreederei G.m.b.H.," is dated January 5th, 1919. On January 6th, 1925, this company became the "Lufthansa," and scarcely twenty years later, the story ended.

Germany's future aeronautical activities were outlined in March, 1945, by Viscount Swinton, then British Minister for Civil Aviation, before the South Africa Air Transport Conference :

"Germany will not be allowed after this war to make, own, or operate aircraft. An international organisation will have to be formed to operate her internal civilian air services."

This meant that German civil aviation was at an end, but it simultaneously signified the beginning of vast commercial flying activities over Germany, which were to develop with astonishing speed, and which today form a focal point of European air politics. These new activities, to which Germany makes no active contribution, did not arise from spontaneous decisions formulated to cope with unforseeable circumstances. They are the fruits of careful and systematic planning.

Long before the end of the war, when American and British bombers were still busy in their day and night struggle for victory, Allied experts appeared on the European continent in order to assess the possibility of later starting civil flying operations. Immediately after the cessation of hostilities, they pursued their investigations on an increased scale. General Eisenhower asked for two advisers from the U.S. Civil Aeronautics Administration to be attached to his headquarters. One of these examined the condition of the ground installations available in Germany, and the other the means which could be placed at the disposal of airway traffic control. And already at the beginning of 1945, the U.S. Civil Aeronautics Administrator, Mr. T. P. Wright, visited the scene personally, and straightaway afterwards, Mr. Fred H. Grieme, Chairman of the CAA Airport Committee, made a tour of Germany.

At the end of 1945, the Civil Aeronautics Board issued the first air route certificate, a rather theoretical and problematic one, for an airline to fly to Frankfurt. It was granted to Pan American Airways. At the end of

Unveiling of the International Civil Aviation Symbol at Rhein-Main Terminal, Frankfurt.

February, 1946, similar authorisation was given to American Overseas Airlines, to fly to Berlin after May, 1946. And at the beginning of 1947 there started a race between all European airline companies for landing rights in Germany. British Overseas Airways Corp. got the right to land at Fuhlsbüttel airport, Hamburg. On February 1st, 1947, the Swedish ABA company also started landing there. A few weeks later, the Danish Government asked the Council of Foreign Ministers to grant free landing rights in Germany to all countries, including neutral States. Today ? BEA, SAA, DNL, Sabena, KLM, Air France, Luxemburg Airlines, Alitalia, Panair do Brasil, thus many of the world's major airline companies, are also effecting landings on German soil—and the great majority at Frankfurt. In 1937, the leading German airports were Berlin with 9,661 arrivals and departures a month, Frankfurt with 6,081, Leipzig with 4,784 and Cologne with 4,638. Today, Frankfurt leads them all, though not under circumstances the Germans would have expected. Across the front of the administration building is written in English, "Rhein-Main Terminal," and the personnel have "American Airlines" written in big letters across the backs of their overalls.

* * *

The story of Frankfurt's airport began on January 2nd, 1934, when the first trees were felled to make way for an ambitious installation. In the summer of 1936, the administration building was opened, and by 1938 two airship hangars had been completed at a cost of six million gold marks, for the "Graf Zeppelin" and the "Hindenburg." These two airships together carried out 150 scheduled flights to South America and ten round flights to the U.S.A., transporting a total of 3,356 passengers. Commercially, this works out at 37,125 gold marks per flight as amortisation for the cost of the hangars, not to speak of the actual operating costs... These lavish habits culminated a few years later, when at the outbreak of war, the hangars were dynamited, the airships dismantled and the entire airport turned into a Luftwaffe base. And in Spring, 1945, well over 2,000 bomb craters were to be counted. What was still left, the Luftwaffe itself took to the grave before evacuating the area. "Unimaginable destruction" were the words of one of the first Allied reporters to reach Rhein-Main airport with the U.S. troops.

* * *

Peace has come back to Frankfurt's airport. Each week nineteen aircraft take off for New York, seven for London, six for Berlin, Munich and Prague. There are daily connections with Copenhagen and Switzerland. One aircraft leaves each week for Brazil.

Peace has come back to Germany. PAA, AOA and BEA are operating internal services and transporting German passengers. On the BEA route from Hamburg to London, Germans have been allowed to travel since last March, and they pay their passage in "German marks." On May 1st, 1948, air-

American Airlines personnel at Frankfurt.

Airmail services have been resumed in Germany.

mail services began between the Western Zones and foreign countries.

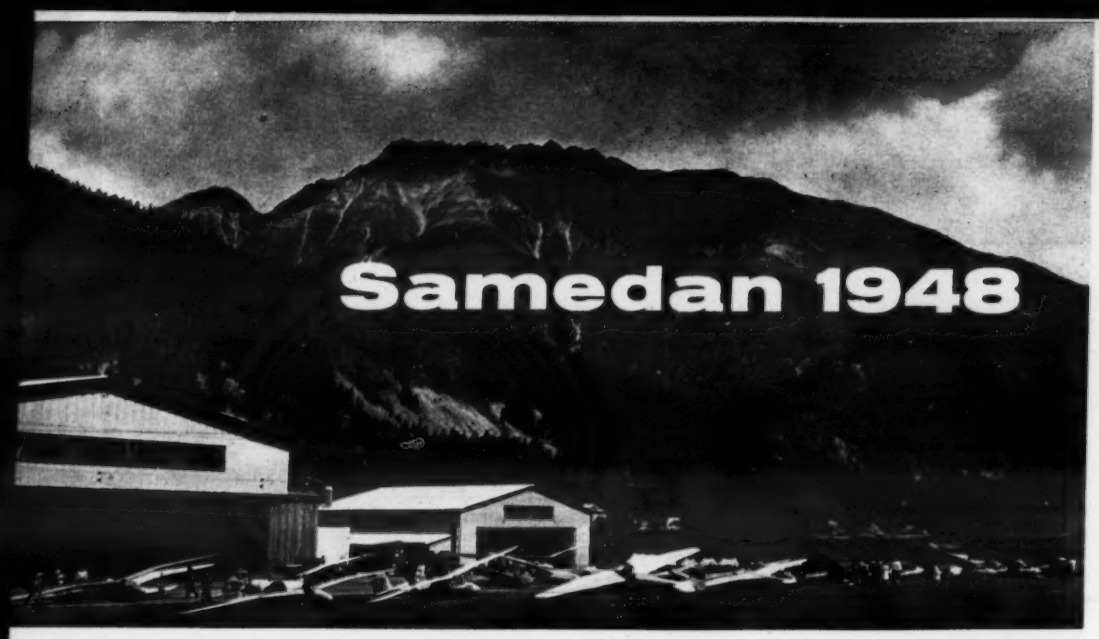
Peace has come back to Germany and will remain as long as the hundreds of transport aircraft flying day and night since the end of June between Frankfurt and besieged Berlin, do not lead to the contrary.

Even in Frankfurt's town council, a small party war broke out—about the costs of the "International Civil Aviation Symbol." Owners of the airport are the "Rhein-Main-Verkehrs-AG.," with the town of Frankfurt holding the majority share capital. This company has leased the entire installation to American Overseas Airlines, but by principle the owners must pay for the buildings. One of the town fathers thought that Frankfurt ought to pay the 14,000 marks for globe and dove without a murmur, since this monument is symbolic of Frankfurt's and Germany's return to international civil aviation. Certain others thought that it was bad business to have U.S. airlines companies doing all the earning and the Frankfurters all the paying.

Meanwhile, the present earnings of American airline companies, especially on German soil, are surely not exactly enormous. And the dove which has finally landed in Germany again, ought to be worth its price.

Airship schedules between Europe and South America, and the Lufthansa's last schedule : Summer, 1939.

International long and medium-distance routes lead to Rhein-Main Terminal ; Douglas DC-4's of AOA and DC-3's of DDL and DNL.



During the second half of July, 1948, the best sailplane pilots in Europe, equipped with the highest quality sailplanes, came to Switzerland. Meeting place of 27 pilots from eight countries was Samedan airfield near St. Moritz, situated at nearly 6,000 feet above sea level. The time was well chosen for this alpine competition between soaring enthusiasts—just before the inauguration in Great Britain of the Olympic Games, in which gliding pilots are not yet allowed to participate. The accomplishments of the various participants, the discipline with which the competition rules were observed, and the true sportsmanship characterising the entire event, proved that glider and sailplane pilots fully deserve admission to the next Olympic Games, on a par with the representatives of other fields of sport.

Guests of honour at Samedan: Lord Brabazon of Tara (centre), President of the F.A.I.; Captain John Jay Ide (right), U.S.A.; Senor Huerta, Spain.

H. Lambert (France) readies his Air 100 high-performance sailplane.

S. Maurer (Switzerland), winner of the speed flight over 100 kms. Aircraft is a "Moswey III."

It's experience that counts! The most is learned in friendly conversation with competitors. A group of participators and helpers are shown here discussing the situation in the shade of a British "Gull IV" sailplane.

P.A. Persson (Sweden) holds the world's height record for sailplanes (8,200 metres gained above point of departure).

It is not the intention here to investigate which country furnished the best sailplane pilots or what noteworthy performances were accomplished in Samedan. Sailplane competitions extending over several days are extremely difficult to assess. Between one competition and another, the weather can change so completely that, although it is possible to determine which were the best performances, a classification of the participants can result in injustice to some. For this reason, the daily accomplishments of the separate competitors at Samedan were corrected through the medium of a daily index, which was computed from the three best results of the day. If the first, second and third results were high, then the index was chosen low; if only medium results could be obtained, then the correction was made in such a manner that the performance of the day could still be listed in the final classification with absolute fairness.

Take-off! P. Mallett (Great Britain) being launched in his "Weihe" sailplane.

A French Air 100 sailplane touches down at Samedan airfield.

Five different competitions were staged at Samedan. In order to give foreign pilots an opportunity to acquaint themselves with the topographical features of the surrounding country, the first event was the competition for *Height Above Point of Departure*, with the gain in altitude recorded on baragraphs. In the *Goal Flight* competition, in which pilots could choose their own points of destination, the result depended on the distance covered; if the landing was effected within 1,000 metres of the goal, then supplementary points were awarded accordingly. The *Out and Return Flight* competition was judged not only according to the distance flown, but simultaneously to the altitude gained. Here, too, supplementary points were awarded if the conditions were fulfilled completely, *i.e.*, if the goal was reached and the landing made at the point of departure.

The last two events were the first *Soaring Speed Competitions* to be held. In the case of the *Goal Speed Flight* race, to a field located 100 kms. from Samedan, the best time was measured; and in the *Speed over a 100-km. Triangular Circuit* event, the best time up to the return to the point of departure.

Representatives of eight nations took part in the events: Egypt, Finland, France, Great Britain, Italy, Spain, Sweden and Switzerland. It was unfortunate that the Americans did not appear, since their participation would have given the event the character of an unofficial Olympic Game. Likewise unfortunate was the last minute withdrawal of the Czechoslovakian and Polish applications. Despite this, the 1948 events at Samedan were a thorough success, which will surely serve to further people's enthusiasm in soaring flight, the noblest of flying activities.

The competitions took place under all weather conditions. Approaching storms were not a reason for postponement.

The British brought two "Gull IV" sailplanes to Switzerland.

In the foreground is the "DFS-Kranich" sailplane belonging to the Spanish representative, Juez Gomez.

The British delegation brought its own motorised equipment, which proved useful in readying and transporting aircraft.

Goal and triangular flights place high demands on pilots. Without a good knowledge of the surrounding country and unless every aerological possibility is exploited, top-level results are excluded.

A. Valette (France) in the speed race with his Air 100.

Showing an "Olympia-Meise" sailplane, belonging to the British delegation, over the Engadine Alps.

"Operation Paperclip"

Since the outbreak of the last war, the world has become accustomed to the queerest of names for the plans and undertakings of the Western Allies. Logically, a code name is only useful if it is quite meaningless and does not convey the slightest indication of what is actually going on.

One of these operations, which has been proceeding quietly under the name of "Paperclip" since the end of the War, and as a matter of fact only reached the ears of the general public during recent months, began when the Americans first marched into Germany and German-occupied countries. The aim of "Operation Paperclip" was to track down and use for America's own purposes, every scientist who had accomplished something of importance in any particular technical domain.

A known fact towards the end of the War was that aeronautical research was the *pièce de résistance* of German science. It is therefore not surprising that this operation was particularly interested in picking up German aeronautical engineers.

And thus started one of the first postwar Allied plans. Even externally, it no longer bore the hallmark of smooth co-operation. Almost from the outset, it was a feverish race conducted according to varying concepts of fair play. Americans, British and Russians did their utmost to lure the best booty over to their own camps, and it was not long before France also began to recognise the value of such experts to her crippled industry. The object here is not to describe the various methods used in attempts to get hold of especially promising German scientists—smuggling them by night out of one occupational zone to another, or promising them money awards for their services. The methods used by the victorious countries were not uninteresting ; but from their choice of scientists from different branches of aeronautical research, certain clues may be found concerning the domains which —at least at the end of the War—evinced the greatest interest.

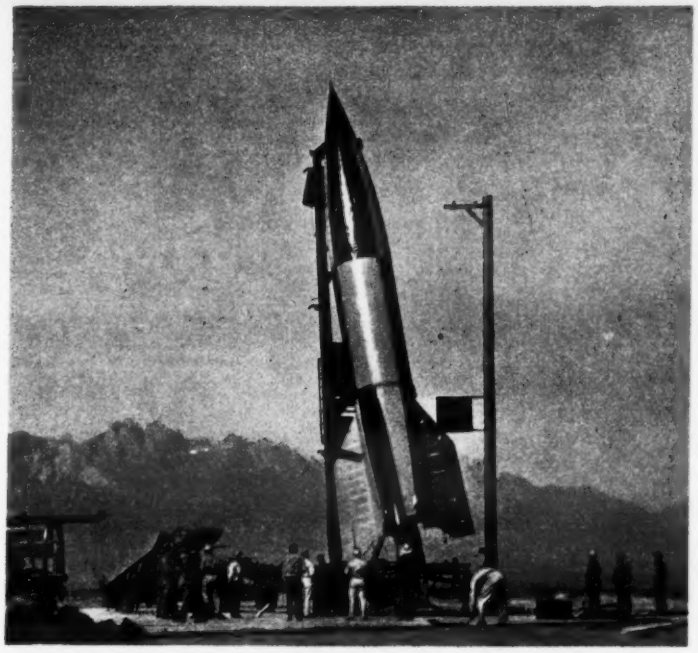
"Operation Paperclip," to begin with the U.S. movement, was not faced with any very great difficulties. Firstly, it was more or less organised before it started, as U.S. Intelligence had previously checked up on German research activities. Secondly, envoys from the realm of dollars did not have to run after their quarries : most of the Germans came forward of their own accord and offered their services. In this way it was possible for a first group of seven scientists to be transported secretly to the U.S.A. in September, 1945. With them went about 1,200 tons of scientific material which Air Force Intelligence had managed to gather. "Operation Paperclip" certainly set up a record, for never before were so many American scientists stuck into uniform and sent abroad. But the trouble and expense has been worth while. The list of German experts in the U.S.A. is long, and many more followed after that first sending in September of 1945. Perhaps the greatest difficulty facing the Americans was to find a loophole in the State Department's bureaucratic barrier against immigration of ex-enemies to the U.S.A. In the absence of a peace treaty, the Germans were finally made employees of the U.S. forces in Europe, on the basis of simple employment contracts, and transferred for temporary duty in the U.S.A.

A main group of German scientists is now at the big U.S. Air Force test centre at Wright Field, Ohio. They include aircraft designers, turbine and rocket specialists, aerodynamicists, parachute constructors and even special doctors, who are all continuing their research from where they left off in Germany. No attempt will be made here to compile a complete list of the German scientists now in America. But a few names will suffice to spotlight the domains and designs at present interesting the U.S. Army, Navy and Air Force.

Dr. Alexander Lippisch, who worked together with his assistant, Ringleb, and two well-known rocket test pilots, Opitz and Hohmann, at Wright Field up to March, 1947 (after which date he was transferred to Philadelphia for the Navy), was chief designer for Messerschmitt's, at Augsburg, and the bearer of many new aerodynamic ideas for high-speed aircraft. The Messerschmitt Me 163 rocket fighter is only one of Lippisch's many aircraft designs, which also included all-wing projects with very sharp sweepback (leading edges sometimes swept back to 60 degrees) for supersonic flight. There are people who maintain that the configuration of the new Boeing XB-47 "Stratojet" six-jet bomber embodies aerodynamic concepts of Lippisch.

That the Americans were interested not only in aircraft construction, but also in general aeronautical research, is evident from the following incomplete list of former German university professors : Dr. W. Kamm, professor of aero-engine construction at Stuttgart ; Dr. E. Eckert, thermodynamics at Prague ; Dr. von der Nüll, turbines and turbo-superchargers at Berlin ; Dr. Ph. Rossman, ballistics at Braunschweig ; Dr. W. Westphal, physics at Berlin. Among aerodynamicists and wind-tunnel specialists may be mentioned : Dr. Ph. von Döpp, formerly chief aerodynamicist for Junkers at Dessau ; Dr. S. Hoerner, chief aerodynamicist for Messerschmitt at Augsburg ; F. Huber, chief aerodynamicist for B.M.W. at Munich ; Dr. R. Herman, chief aero-dynamicist at Peenemünde ; Dr. W. Knackstedt, from the Hermann-Göring aeronautical research organisation in Braunschweig. Another research group at Wright Field includes many well-known engine specialists : Dr. R. Amman, P. Kappus, B. Bruckmann and Dr. A. Hussmann, all from B.M.W. ; Dr. A. Franz, H. Berkner, Dr. H. Schmitt and Dr. F. Neugeber, all from Junkers, as well as rocket experts W. Singelmann, H. Müller, H. Gartmann and H. P. Ehrhardt. The Wright Field group also includes remote-control led flight specialists Dr. O. Stützer, Dr. H. Mayer, and a former Blohm & Voss expert, Dr. Vogt.

Messerschmitt Me 163 rocket fighter, one of the last constructions of Dr. Alexander Lippisch, who is today working on new high-speed aircraft for the U.S. Navy.



Tests with V-2 guided missiles at White Sands, Texas, are being conducted with the help of Dr. Werner von Braun.

Articles published during the past two years on U.S. experiments with V-2 rockets prove the keen interest displayed by the U.S. Air Force in the guided-missile field. It is no secret that these experiments have been proceeding under the guidance of German scientists. One of the formerly closest guarded groups from Peenemünde is now working under Dr. Werner von Braun at the White Sands test centre in Texas.

The conditions under which German scientists work for their ex-enemies are not exactly regal, but they are above the average living conditions in Europe. After expiry of the first six-month contract, it is usual to sign a five-year contract, which averages 5,000 dollars a year and thus offers a standard of living which can certainly not be found in Germany. And since they will be granted an opportunity to become U.S. citizens after a certain period, it is safe to guess that a good number of the German scientists will remain true to their "new" home.

* * *

By far the smallest number of German scientists was probably taken over by Great Britain. Here, too, preference was given to rocket specialists, including a series of engineers who formerly worked for the Walter concern in Kiel. It was only a few months ago that the newspapers reported an accident in this field, causing the death of the best-known German scientist in England, Dr. Schmid, formerly chief designer for the Walter-Werke.

* * *

France, who was above all interested in collecting jet-engine specialists, has obtained the co-operation of the former head of the B.M.W. turbine division, Dr. Oestrich. Another large group of specialists was sent to the south of France, to work on a big turbine project. As this project has since been abandoned, however, it is possible that the group will be dissolved and its members sent back to Germany.

* * *

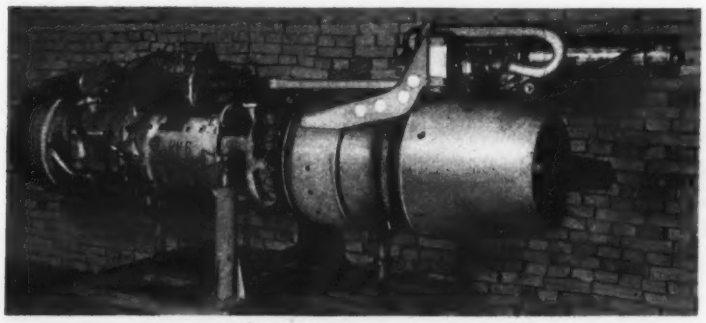
The Soviet Union had other methods of recruiting German specialists who seemed to be of use. No sooner had Berlin been occupied than a special commission began evaluating all the scientific material it could lay its hands on. Some material included lists of names which had escaped the planned destruction procedure. This gave the Russians a lead to the identities and whereabouts of many engineers. For instance, the head of the rocket development division of B.M.W. at Zühlsdorf, Berlin, Dr. K. Schnell, was hauled out of bed in the middle of the night, and dragged off with this firm's chief designer, W. Singelmann, to their former factory. Together with a few mechanics they had to assemble, from what parts remained, rocket equipment for test bench runs. Under pressure, a number of workers revealed where finished equipment was buried under the ground or at the bottom of lakes and rivers. In this way the Russians were able to fish up one device after another, from the bottom of lakes around Berlin. The Soviet Commission was especially interested in the 109-718 rocket complement for the turbine of the Messerschmitt Me 262 B twin-jet aircraft. This apparatus, first used in March, 1945, at Lechfeld airfield, Augsburg, represents a combination of a Junkers turbine with a Walter rocket unit, and was built into the Me 163 fighter. It furnished the Me 262 with such a reserve of power (the rocket complement delivers over 4,000 lbs. thrust) that this aircraft succeeded in climbing to 50,000 feet in three minutes.

A little later the Russians established a big test centre at the former Siebel aircraft factory in Halle an der Saale, and had almost the entire Junkers development staff transferred there from Dessau and Köthen. Well cut off from the outside world, these men continued to develop airframes for supersonic aircraft, including the airframe of the Junkers Ju 287 jet project (with forward-swept wings).

Members of the "Siebel" group, who were soon joined by former engineers from B.M.W. concerns in Spandau, Stassfurt and Munich, etc., were not only assured that they would stay in Germany and never be transferred to Russia, but were also offered princely salaries and priority living conditions. According to their contributions, they were paid anything from 1,000 to 10,000 marks a month. These conditions lured many specialists from all occupational zones, though a few were chary and preferred to sign up with the U.S.A. Among these were W. Singelmann, and the two rocket experts, Gatmann and Ehrhardt.

The "Siebel" group no longer exists today. At the end of last October it was transferred, along with many other German scientists, at a few hours' notice to various parts of Russia. Since then, little or no news has seeped out westwards ; some of these scientists seem to have disappeared completely. The majority of the engineers who, under Russian orders, conducted the clean-up of the V-2 test centre at Peenemünde, were also dragged off to Russia. Nothing has been heard of them since.

The B.M.W. 109-718 rocket complement was a focal point of Russian interest after the War. It is shown here built on to a B.M.W. 003-R jet engine, as foreseen for installation in the Messerschmitt Me 262 B jet aircraft. The two rocket units provide this aircraft with over 8,000 lbs. of additional thrust.



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It is quite impossible to give even an approximate figure for the number of German scientists employed by the Allied nations today. And it is only seldom that one hears details of their activities. However, it is fairly sure that their identities will occasionally be revealed in the aircraft, engines and guided missiles of the next few years.

H.—P.E.

Something New In Rotary Wings

Among efforts to build simpler and cheaper helicopters, worthy of mention is the work of *Rotor-Craft Corporation,* in Glendale. Cal., and of this firm's 35-year-old president and designer, Gilbert Magill. Their XR-11 twin-rotor experimental helicopter, which has been under development for the past three years and has recently been submitted to its initial flight tests, reveals a series of interesting design details which differ from hitherto conventional practice and sometimes indicate radically new paths. Before examining them, it will be profitable first to summarise the general characteristics of the new Rotor-Craft.

Rotors : Three-blade design with wooden blades, positioned in tandem, contra-rotating with overlapping discs, not hinged or flapping ; front rotor (seen from above) rotates anti-clockwise, rear rotor clockwise; rotor diameter about 18 feet, total disc area approximately 508.7 sq. ft.

Power Plant : Continental C-100 flat-four modified to yield 3,200 r. p. m., cooled by a suction fan ; 1 : 7 two-stage gear reduction for rotors ; six-gallon fuel tank and five-quart oil tank slung under the engine.

Fuselage and Undercarriage : Two seats in at present open fuselage of welded steel-tube design ; distance between rotor shafts of 12 ft. 4 ins. Tricycle undercarriage ; "pantograph rod," a light rod carried from the oleo fork outward and above the axle to a point above the bearing which joins the wheel fork to the main axle, assures vertical position of each wheel ; oleo strut has a 14-inch travel ; all wheels are castering, but the main wheels are held rigid, to ease ground handling, by shear pins which snap in the case of a strong side force.

Control system : Column for control about lateral and longitudinal axes, pedals for control about vertical axis ; combination throttle and collective-pitch lever (lever in the photo, shown close to throttle lever, is experimental for rotor paddling tests, and will not be in the production model). There are no cables, all control being by rod linkage.

Weights and Performance : Gross weight 1,350 lbs. (with two occupants) ; disc loading 2.3 lb./sq.ft. Engine output is 110 H.P. No details are available on flight performance.

Power plant of the Rotor-Craft is a Continental C-100 modified to turn at 3,200 r.p.m. Visible are the cooling fan and clutch assembly, and the main gear box, of magnesium, delivering power to the front and rear rotor driving shafts.

The most striking feature of the Rotor-Craft is the new rigid rotor concept, without hinges or flapping joints. Even the degree of blade freedom offered by a see-saw attachment of rigidly-opposed blades to the driving shaft (as in Bell helicopters) is absent. The rotor disc always remains perpendicular to the shaft, so that the two rotors embody a principle similar to that of controllable-pitch propellers. Meanwhile, one of Magill's revolutionary ideas involves an *excentric* position of the blades at the rotor hub ; in other words, their axes do not intersect in the axis of rotation, but run behind it and have, therefore, a kind of "sweptback" configuration (see diagram). This enabled the pitch control rods to be placed within a hollow driving shaft, the usual cage-like mass of external control rods and moving part to be avoided, and the entire rotor hub to be given a very simple and clean configuration. (The blade roots carry levers which protrude through slots into the hollow shaft to connect with their respective pitch-control rods.) Moreover, through the "sweptback" form of the rotor blades, they pivot about a point *above and ahead* of the aerofoil during pitch changes. Cyclic pitch changes are therefore accompanied by a limited vertical movement of the blades, which, superimposed on the resultant horizontal speed of each blade element, results in a collective change in the effective angle of blade pitch. The amount of cyclic feathering has thereby been reduced considerably. As this "flapping" movement of the blades all the same stays very small, and air and mass forces almost entirely cancel it out, the XR-11, contrary to helicopters with flapping hinges, does not make it necessary to have the blade's centre of gravity coincide with its centre of pressure. For this reason, it is possible to utilise low-cost blades of laminated birch (C.G. at approximately 44 per cent. of chord and C.P. and 25 per cent.) or blades developed from a swaged metal tube. This means a big saving, since the hinged blade is otherwise a complex affair, which has to be carefully weighted and therefore becomes very expensive.

Besides these, the XR-11's designer has pursued other aerodynamic goals. An "ideal" rotor configuration, still in the test stage, should enable blades to be moved automatically to their most efficient angle of attack in the event of a breakdown in the control system : to ten degrees pitch with power on, and to four degrees for autorotation in the event of a reduction or loss of power. Still more ambitious is a rotor loading system planned to give the XR-11 inherent stability. Whether, and to what extent, these two ideas will prove successful, remains for practice to show. Magill assures that his helicopter's stability characteristics are already that good : the C.G. of the complete aircraft is placed at a distance about 40 per cent. to the rear of the front rotor shaft, thus subjecting the forward rotor to about 50 per cent. more disc loading than the rear rotor.

It would seem that the XR-11's urge to return automatically to a horizontal-flight attitude is attributable to this combination of unequal disc loading ; in hovering flight, it has to be held through a slight back pressure on the control column. This furthermore gave rise to the necessity of tilting the rear driving shaft half a degree to the left in order to balance out the remaining rotor torque moment. Hence the rotor disc planes are not exactly parallel to each other. In view of the overlapping configuration, the rear rotor is positioned higher than the front one, which is probably also advantageous from the standpoint of downwash effect.

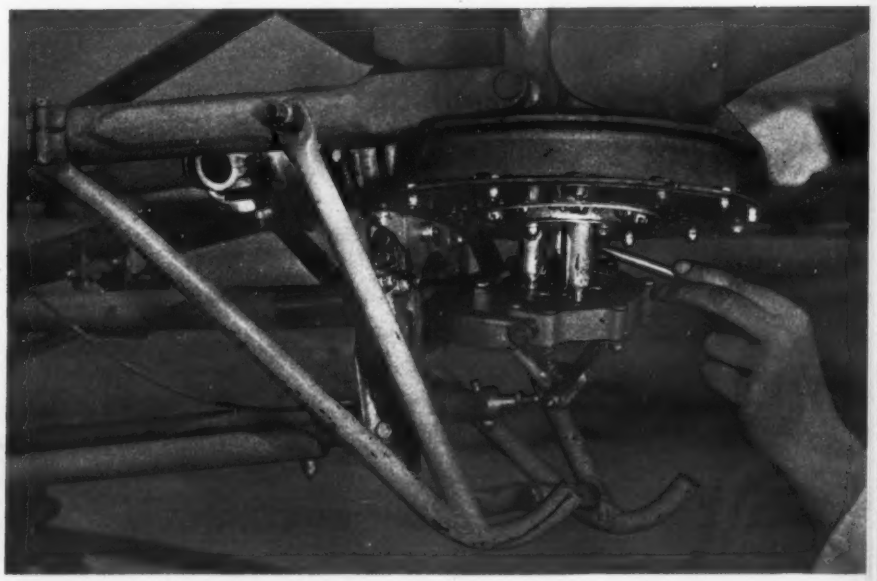
The swashplates, for cyclic and collective pitch change, are mounted at the bases of the rotor driving shafts, on a level with the cockpit controls. This has enabled the number of parts for transferring control movements to be reduced considerably. As the photo of the rear rotor swashplate assembly shows, the design is indeed very simple. A horizontal gear shaft drives the vertical rotor driving shaft through a reduction gear, whence branch off three co-rotating control rods which are linked with the pitch levers above and the small three-inch-diameter swashplate below. The swashplate can be tilted fore and aft, and raised or lowered (through a terminal crank), by the control rod and the two push-pull rods. In this way the blade pitch can be changed cyclically (in the separate sectors of its circular path) and collectively.

According to the manufacturers, the control is characterised by extreme sensitivity and almost imperceptible lag in control response ; control forces are low, and the frequent feedback of forces into the column are not evidenced by the XR-11. Moreover, the control movements are small : in banking, not more than $\pm$ 3 degrees of pitch change are necessary, and only $\pm$ 2 degrees in fore and aft motion. A further feature is the self-centring of the controls, which is purely aerodynamic and needs no mechanical device. Central position of the controls, thus neutral position, gives moderate forward speed.

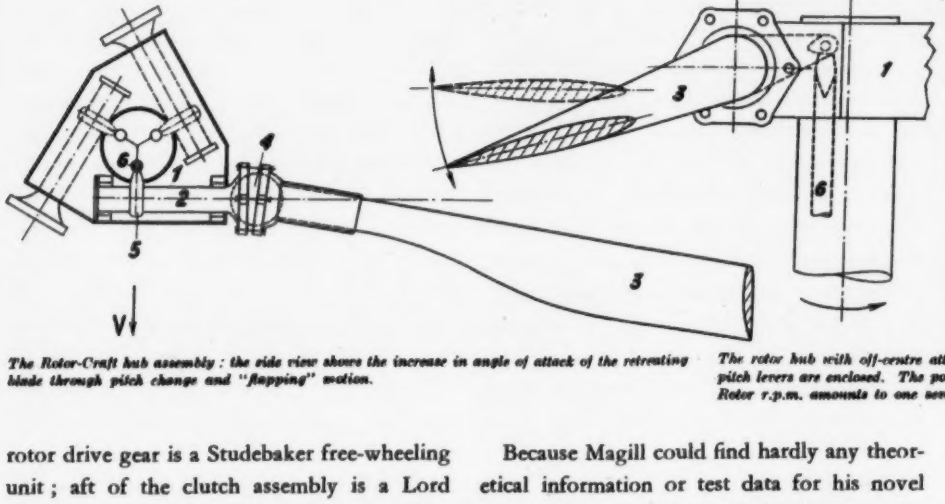
Another feature making for low costs is the application, wherever possible, of standard automotive parts in the power plant, gears and transmission organs. The rotor clutch, for example, is a modified Ford clutch ; the final

Showing the gearbox, engine shaft and control rods; also the "pantograph" displacement and soft springing of the main undercarriage wheels.

Inside the hollow driving shafts of the rotors run the control rods for pitch change. One control rod and two push-pull rods adjust each swashplate.



1 : Rotor shaft and hub. 2 : Blade spindle. 3 : Blade. 4 : Blade root. 5 : Tilting lever. 6 : Control rod.



The Rotor-Craft hub assembly : the side view shows the increase in angle of attack of the retreating blade through pitch change and "flapping" motion.

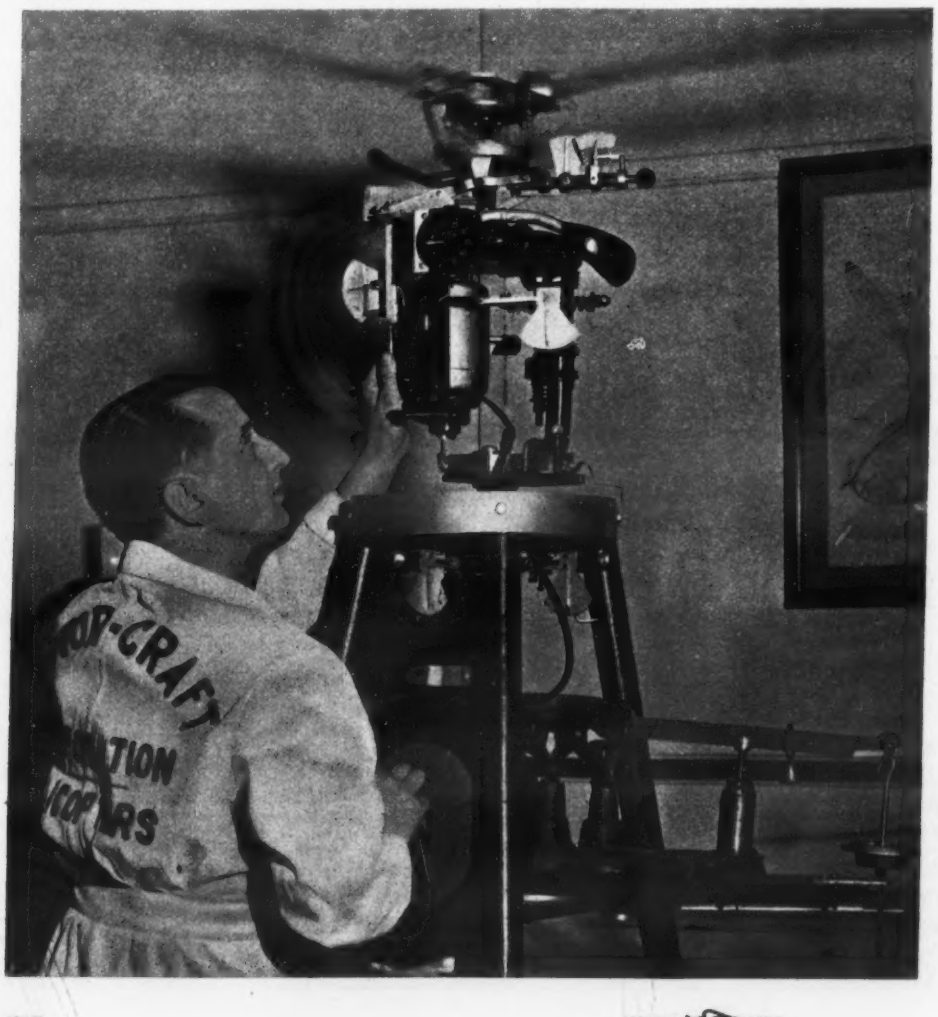
The rotor hub with off-centre attachment of blades is simple and compact. All control rods and pitch levers are enclosed. The position of the aerofoil in relation to the pivoting axis is adjustable. Rotor r.p.m. amounts to one seventh of engine r.p.m.

rotor drive gear is a Studebaker free-wheeling unit ; aft of the clutch assembly is a Lord rubber torque disc ; and the main gear box assembly has every characteristic of a catologued article from the automobile industry.

It should be noted here that, in the production model of the XR-11, the combination throttle and collective pitch control lever will be fitted with a throttle over-ride in the form of either a small thumb lever or a twist-grip.

Because Magill could find hardly any theoretical information or test data for his novel rotor system, he had no choice but to create his own. For this purpose, he built a small but fairly elaborate rotor test stand to try out his ideas on quarter-scale rotor assemblies. This comprises an electric motor as power source, a tachometer, and an assembly of spring-loaded balances. The rotor drive, with adjustable hub, is equipped for cyclic and collective pitch control, and azimuth control.

The Magill test stand for quarter-scale model rotor assemblies, with electric motors, tachometer, gauges for measuring rotor forces.



Besides all control forces, readings can be registered of pitch, roll and torque moments ; for measuring lift and side forces, the test stand is mounted on a truck driven at different speeds along a smooth track.

Whether the experimental XR-11 will be followed by a series of production models, is largely dependent on the outcome of the present flight tests. These may induce the U.S. Air Force, which has so far helped to finance the project, to grant an experimental production contract.

Notwithstanding its structural simplications, the XR-11 will probably still have to cope with the usual rotary wing "bogeys" of tare and gross weight, and engine continuous power. It was not without reason that the engine was modified to develop one third more r. p. m. The stability behaviour, concerning which only scanty information is available, is a major point in this as in every other helicopter. However, the tandem positioning of the rotors seems to offer many advantages, most of all as regards longitudinal stability. Even in the event of side gusts, balance disturbances effecting the front rotor would be compensated by counteracting disturbances against the rear rotor. Finally, it is well known that the position of the C.G. need not be selected with such great care where tandem rotors are concerned, since it can be balanced by differing collective pitch change. Moreover, the absence of an auxiliary rotor for anti-torque makes it unnecessary to coordinate pedal travel and collective pitch change.

Rotor-Craft Corp. is intent on pursuing its efforts and invading the commercial market. Magill estimates the unit price at $10,000 for a first series of 500, followed by a scale-down to a final price of $5,000 for a two-seater. And judging by the artist's conception of a big transport version, visible on the wall in the test stand photo, it would seem that there is no lack of ambition in this young firm.

The Air Hostess Told Us ...

Post Tenebras Lux.

Esmeralda, our Favourite Air Hostess, has come up with a bright suggestion. She blew in from Paris recently and was registering enthusiasm. Air politics interested her, she said, particularly those illustrious bodies, the International Civil Aviation Organization and the International Air Transport Association.

ICAO, she declared, ought to break away from the United Nations. It should quit Montreal, together with IATA, and join CIE in the French capital. What we asked, is CIE, and why should it be joined by IATA and ICAO ? CIE stands for "Commission Internationale d'Eclairage," explained our Favourite Air Hostess. I was at their meeting in Paris late in June and early July, she said, and wasn't that something ? They obviously talked about airport approach lighting and similar unintelligible stuff, but they also went places ... and I said *places*.

Now, what can anybody do in Montreal ? You can get a steak as big as your hat at the Blue Danube on St. Catherine's, or listen to a songstress on the Normandie Roof, or go to a clip joint where you see nothing, not even the rest of your dollars. In Paris things are different. CIE's entertainment budget enticed delegates into a super-sophisticated dinner, complete with lackeys in powdered wigs, knee-breeches and silk stockings, at the former seat of one of France's oldest families, aristocratic Hôtel de Rohan ; into a less sophisticated tear at Ledoyen's on the Champs Elysées the next night ; and just a binge in Montmartre the following evening. They also visited the Louvre after dark, where brilliant lights were switched on for the occasion (the caretakers counted the paintings after the delegates' departure). They went to the Château of Versailles, listened to a concert at the chapel there, tried to look like the Water Babies while admiring the famous fountains in the grounds, had a whacking great dinner, and finally watched a ballet in the Versailles Orangerie. Apart from that they were lured to several cocktail parties.

They left Paris happy in the thought that good old Europe had not forgotten how technical conferences should be organized, and they were glad that this latest meeting in the Ville Lumière was unable to solve all the complex problems of "Eclairage"—aeronautical and others—in one fell swoop. Some were left over for another time.

Now you see the possibilities ? asks our Esmeralda : if ICAO, IATA and CIE joined forces, they could paint the town several shades more purple at a considerable saving of time. They could also head their agenda on the lines of the U.S. National Aeronautic Association's programme for the 1948 Convention at the end of June, which read : "See you at Minneapolis ... there's FUN Ahead for Everyone !"

Flying Booby Hatches ?

The aeroplane, Esmeralda says, is increasing its reputation as an infallible cure for the world's evils. For some time, kids have been taken up to thousands of feet, put through a couple of outside loops, and have come down minus their whooping coughs. Doctors are still trying to figure out why, medically, the phenomenon cannot exist.

The practice now spreads to other fields. At the beginning of June, ten-year-old Barbara Ann Ogg was taken up 14,000 feet above Springfield, Illinois, in a Navy training plane. The pilot dived through 8,000 feet, and Barbara Ann was able to hear again, after several years of deafness. The pilot reported a slight buzz in his own ears. — About two weeks ago there came a young man from Odense, in Denmark, who had made himself a local reputation for being the most accomplished stutterer. He was loaded into an aeroplane, the pilot performed every manoeuvre in the book, and when they landed the young man from Odense said "Popocatepetl" without getting stuck.

Wonderful, says E., our F.A.H. Next time you get St. Vitus' dance or rheumatism (not simultaneously, we hope), off you go in an aeroplane. Go safely off your mind—the aeroplane will put you right. Get a shot of D.T.—the pilot will dive, roll, climb, loop and spin you back to your senses. Unless, of course, he stalls you into being a split personality.

Uncle Sam and Uncle Joe.

Esmeralda says she was at Dayton, Ohio, in the middle of July and was astonished to hear a Probate Judge place a valuation of one single dollar on the famous Kitty Hawk, the biplane in which the Wright brothers made their first flight of 852 feet in 1903. She was soon taught that the valuation was purely for tax purposes and a preliminary step to the return of the priceless aircraft from the Imperial Science Museum in London to the United States.

She became sceptical again, however, upon listening-in to Moscow Radio on the same day. The Wright brothers, she learned, were not the inventors of the aeroplane. This feat was accomplished twenty-one years earlier—according to documents "discovered" in Leningrad —by one Captain Alexander Mozhaisky. The contraption was claimed to have been able to fly but "lost its balance owing to insufficient stability." What happened to Alexander himself is a mystery. Esmeralda suspects that the disclosure of this Russian invention is probably the real reason why the Wright biplane was written down to a dollar ...

On the other hand, she says, she once invented a toothbrush which didn't work owing to the absence of bristles.

Well, we guess this item is just part of a much bigger programme. What with Uncle Sam's LeMay Food & Coal Inc. and Uncle Joe's Wheat & Bread Collective Corp. trying to outdo each other in feeding the Berliners, the international situation does not look so smooth at the moment. Which is a pity. If the two big boys got on together you wouldn't have to talk about Uncle Joe and Uncle Sam. You could call them Uncle Samovar.

Bl.

Official Bulletin of the
FÉDÉRATION AÉRONAUTIQUE INTERNATIONALE, PARIS

At a meeting of the F.A.I. Commission on Gliding, held at Samedan on July 27th and 28th, 1948, the following items were studied :

1. Proposals by the National Aeronautic Association of America, suggesting modification of certain articles in the regulations governing duration records returning to points of departure, and the definition of vertex determination in altitude records.
2. Final examination of the regulations for new records with sailplanes. (Proposed by the Swiss Aero Club.)
3. International sailplane competitions for 1949. The Aero Club of the Polish Republic suggested that they organise these competitions at the Zar Gliding Centre.
4. Gliding competitions during the 1952 Olympic Games. The choice of an Olympic sailplane. (Proposed by the Finnish Aero Club.)
5. Relations between the F.A.I. Commission on Gliding and the new organisation destined to succeed ISTUS. The name to be given to this organisation.
6. Detailed account of the gliding competitions which took place at Samedan. Observations to be deducted therefrom.

The results of the work accomplished by the F.A.I. Commission on Gliding will be published in the next issue of "Interavia."

Homologation of new records by the F.A.I.

International Records

Class C

Speed over a closed circuit of 2,000 kms. (U.S.A.)

Miss Jacqueline Cochran
North American P-51 single-seater (NX 28388)
Packard-Rolls-Royce "Merlin" engine of 1,450 H.P.
From Santa Rosa Summit, California, to Santa-Fé, New Mexico
May 22nd, 1948 — *720.134 km/hr.*

Class G (Helicopters)

Speed over measured course (Great Britain)
Squadron Leader Basil Henry Arkell
Fairey G-AIKF helicopter
Alvis "Leonides" (No. 16) engine of 500 H.P.
White Waltham airfield, Berkshire
June 28th, 1948 — *200.0657 km/hr.*

International Women's Records

Class C

Speed over closed circuit of 2,000 kms. (U.S.A.)

Miss Jacqueline Cochran
North American P-51 single-seater (NX 28388)
Packard-Rolls-Royce "Merlin" engine of 1,450 H.P.
From Santa Rosa Summit, California, to Santa-Fé, New Mexico
May 22nd, 1948 — *720.134 km/hr.*

Speed over a closed circuit of 1,000 kms. (U.S.A.)

Miss Jacqueline Cochran
North American P-51 single-seater (NX 28388)
Packard-Rolls-Royce "Merlin" engine of 1,450 H.P.
From Santa Rosa Summit, California, to Santa-Fé, New Mexico
May 24th, 1948 — *693.780 km/hr.*

Class D (Gliders). Category I

Altitude (France)
Mme Mathé
"Meise" sailplane No. 12
Saint-Auban-sur-Durance
June 4th, 1948 — *6,730 metres*

Book Reviews

L'Avion-Cargo. — By François Serraz. Les Editions Internationales, Paris.

Over ten years ago there appeared in France a comprehensive book on bomber flight (Camille Rougeron), which subsequently became a standard work and is still today one of the most frequently used sources of information in its domain. Air cargo transport, and also the cargo aircraft as such, today stand at the beginning of their development. It may be that this extremely detailed study by Mr. Serraz is likewise destined to become a reference work of lasting value to this new branch of air transport. Following a thorough investigation of the commercial potentialities of the cargo aircraft, and of the characteristics of the transport commodities, the author uses the experience of air transport organisations during the war, to outline the prospects of international air cargo transport. The third part of the book is devoted to the legal principles (Mr. Serraz is a lawyer) and the decisions and regulations formulated so far by ICAO. (French.)

Manuel du Commandant d'Avion. — By Captain F. Lamy. Blondel la Rougery, Paris, 1948.

It was only during the course of the last war, with the general introduction of four-engined transport aircraft manned by several crew members, that a definition of the position of the aircraft captain, his duties and scope of responsibility, became extremely urgent. Previously, the rules were more often than not only very theoretical. Just as the captain of a ship, his word is law after the aircraft has left the ground.

To the best of our knowledge, Captain Lamy is the first to group — in his "Handbook for Aircraft Captains" — all that an aircraft captain should know apart from the pure piloting of his machine. It goes without saying that he has used the international traffic rules and general decisions worked out since the war by ICAO as his basis. Meanwhile, credit must be given to the author for having sorted out the mass of international rules and regulations, and presenting in a clear and simple manner the essential principles of international civil aviation operations. His handbook (for once a real handbook of less than 200 pages) should be displayed in the home of every crew member and in a prominent spot on board every airliner. (French.) *Bi.*

New Weapons for Air Warfare. — Edited by Joseph C. Boyce. Little, Brown & Co., in association with Atlantic Monthly Press, Boston, 1947.

Issued under the patronage of the U.S. Office of Scientific Research and Development, this book is one volume in a series of highly interesting books on "Science in World War II." It is concerned with the development of new devices to control the behaviour of shells, bombs, rockets and other missiles, which was the work of special divisions of the National Defence Research Committee (part of the OSRD). It begins with a description of compution devices for fire control, target recognition, distance measurements, and so forth, and goes on to sum up the work which finally led to the construction of the complicated radar fuzes, of which the latest models are still on the secret list. Highly interesting is the account given of the great difficulties confronting the early development of remote-control devices for unmanned aircraft-type bombs.

It is an exceptionally informative book, which will interest others than technicians and military experts. Its style is as racy as that of a novel, and it reveals, better than the most exact of statistics could do, the spirit to which the American war industry owes its enormous potential of World War II. *Bi.*

THE MONTH IN REVIEW

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AVIATION POLITICS

● The Franco-Chinese air traffic agreement, which was due to expire on June 30th, has been extended to December 31st, 1948.

● Anglo-Italian negotiations for a bilateral air agreement are expected to be resumed, after being interrupted several times. According to reports from Rome, one of the chief difficulties in the negotiations is Italy's wish for commercial landing rights at Paris on the Rome—New York service. The French, for their part, would prefer to exclude the possibility of Italian competition on the Paris—New York leg of the route.

FIRST FLIGHTS

● The *Arsenal VG 70* experimental aircraft, powered with a Junkers Jumo 004 gas turbine, made its first flight from Melun-Villaroche airfield.

● The *SIPA S. 901* two-seater personal aircraft, a special version of improved design and higher performance of the SIPA S.90, made its initial flight from Villacoublay aerodrome on June 26th, 1948. The SIPA S.901 is powered with a 75-H.P. Minié flat-four.

NEW AIRCRAFT

● *Douglas Aircraft Co.* has been awarded a USAF contract for 28 *Douglas C-124* four-engined transport aircraft. The type is a larger version of the Douglas C-74 "Globemaster" and designed for the carriage of troops and equipment. It can also be used as a hospital aircraft. Power plant comprises four 3,500-H. P. Pratt & Whitney R-4360 "Wasp Major" air-cooled 28-cylinder four-row radial engines. Span is 173 ft. 3 in., length 127 ft. 2 in., height, 48 ft. 3 in. and gross weight 175,000 lbs., including payload of 50,000 lbs.

Douglas C-124.

● The production model of the *Curtiss F-87* two-seater long-range jet fighter will be powered with two General Electric TG-190 (J-47) turbo-jets of 5,000 lbs. static thrust each. The XF-87 prototype was fitted with four Westinghouse 24 C jets of 3,000 lbs. static thrust each.

● The *Ryan X-5* is a supersonic experimental aircraft being built by *Ryan Aeronautical Co.*, of San Diego, Cal.

● *Douglas Aircraft Co.* is building the prototype of a new two-seater trainer for the USAF. The type is a tricycle low-wing monoplane. The engine will be fully enclosed in the fuselage to the rear of the cockpit ; tractor airscrew driven by an extension shaft passing under the cockpit. Power plant will be a Wright R-1300 "Cyclone 7" air-cooled 7-cylinder radial engine delivering 800 H. P. at take-off.

● *North American Aviation Inc.* has received a USAF contract for 268 *North American T-28* two-seater trainers. The type, which will be used for primary and basic training, is a low-wing monoplane with retractable nose-wheel landing gear and is powered with a Wright R-1300 "Cyclone 7" air-cooled 7-cylinder radial of 800 H.P. Gross weight is 8,562 lbs., maximum speed 292 m. p. h. and service ceiling 31,650 ft.

● The *Dassault D 315 "Flamant"* twin-engined communications and ambulance aircraft, which is intended for the French Colonial Service, is also to be built in a special passenger transport version designated *Dassault D 316*. Work on the prototype has not yet started.

● *SNCA du Sud-Est* is designing a jet fighter designated *SE 2400* and an all-wing aircraft designated *SE 1800*.

● Final assembly of the *NC 1071* torpedo and dive-bomber prototype will start shortly. The aircraft, a product of *SNCA du Centre*, is being built at Toussus-le-Noble and will be powered with two Rolls-Royce "Nene" turbo-jet engines. The NC 1071 is similar in design to the NC 1070 carrier-borne torpedo and dive-bomber, which is powered with two SNECMA 14R air-cooled 14-cylinder twin-row radial engines of 1,600 H. P. for take-off. Flight tests with both types will begin in the near future.

● The *NC 211 "Cormoran"* four-engined cargo prototype crashed in the vicinity of Villacoublay aerodrome on July 20th. All five crew members were killed. The aircraft was being flown from Toussus-le-Noble to Villacoublay.

● *N. V. Verenigde Nederlandse Vliegtuigfabrieken Fokker* has completed full-scale mock-ups of the *Fokker S.13* twin-engined five-seater training aircraft and of the *Fokker S.14* jet-propelled trainer. The latter is to be powered with a Rolls-Royce "Derwent" turbo-jet.

● The *Yakovlev Yak-16* twin-engined commercial transport is an all-metal low-wing monoplane of monocoque construction. Built to accommodate ten passengers and a crew of three or four, it was developed as a feeder transport and for transitional training. It is already in service on the airlines. The engines are ASch 21 air-cooled nine-cylinder radials developing 700 H. P. for take-off and rated at 570 H. P. ; two-blade c. p. airscrews.

Yakowlew Yak-16.

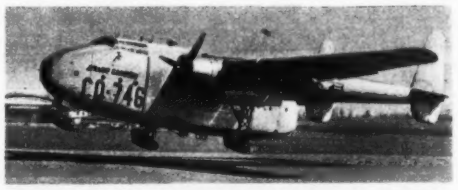
POWER PLANTS

● The *de Havilland "Ghost"* turbo-jet engine, production of which will shortly start at the plant of *The de Havilland Engine Co. Ltd.*, has been approved for civil use by the Air Registration Board. The approved type certificate is limited for the time being to a maximum static thrust of 4,450 lbs. and 250 hours between overhauls. Approval is later to be extended for a static thrust of 5,000 lbs. for similar between-overhaul periods.

● The *Rolls-Royce "Clyde"* propeller-turbine engine, which develops 3,000 shaft horsepower together with 1,200 lbs. residual thrust, has passed the official 150-hour type test. The engine features two co-axial compressors (a nine-stage axial compressor and a single-stage radial compressor), in addition to a single-stage turbine for driving the compressors and the airscrew.

INDUSTRY

● *Fairchild Engine & Airplane Corp.* is building caterpillar type landing gears for the *Fairchild C-82 "Packet"* twin-engined military transport aircraft in considerable numbers. For the time being, 18 "Packets" in service with the USAF are to be equipped with the new landing gear.



Fairchild C-82 "Packet" with caterpillar gear.

RESEARCH

● At the Summer Meeting of the U.S. Institute of the Aeronautical Sciences (Los Angeles, July 15th-16th), *Herbert H. Hoover was presented with the Octave Chanute Award.* Hoover is a test pilot for the National Advisory Committee for Aeronautics and one of the four pilots who have flown the Bell X-1 experimental aircraft at supersonic speeds. The *Thurman H. Bane Award* was conferred upon *Colonel James M. Gillespie*, commander of the Douglas C-54 four-engined transport which in September, 1947, crossed the Atlantic under radio control.

Herbert A. Hoover.

James M. Gillespie.

AIR TRANSPORTATION

● EUROPE : The British Cabinet authorised on July 15th the *purchase of 22 Canadair DC-4M* four-engined airlines for BOAC, at a cost of about 12,000,000

* Excerpts from Nos 1489-1497 (July 6th to July 24th, 1948) of "Interavia, International Correspondence on Aviation," an illustrated newsletter published thrice weekly in three language editions, English, French and German.

Canadian dollars. Canadair Ltd.'s "pay-as-you-earn" terms apparently induced the British Government to give the aircraft preference over some modern American designs.

● *British Overseas Airways fleet* in 1950 will comprise the following four-engined passenger aircraft: 22 Canadair DC-4M-4, 25 Handley-Page "Hermes IV," 11 Lockheed "Constellations" and six Boeing "Stratocruisers." Shortly afterwards the fleet will be augmented by Bristol "Brabazons," Bristol M.R.E.175s and de Havilland "Comet" jet airliners.

● *Scandinavian Airlines System's* Air Freight Centre in Oslo has 10 Douglas DC-3 aircraft at its disposal: 2 are based at Oslo, 3 at Stockholm and 5 at Copenhagen.

● *German nationals may now use the British European Airways Hamburg—London service.* Hitherto they were only allowed to use German domestic air services.

● *An air mail service* has been established *between Italy and Germany*, the first after interruption of about five years. The service is restricted to the Western Zones of Occupation.

● Negotiations are in progress for forming a new Italian airline company in which Transadriatica of Venice, Airone of Cagliari and SISA of Trieste would be merged.

● *Società Transadriatica di Navigazione Aerea* has established two new weekly services: Venice—Frankfurt and Venice—Budapest.

● INTERCONTINENTAL SERVICES: *Scandinavian Airlines System* made its *1,000th scheduled North Atlantic flight* on July 13th. The Stockholm—New York route was officially opened on September 17th, 1946.

● The British Government has decided to allocate *Saunders-Roe SR/45* giant flying-boats to *British South American Airways* instead of BOAC. They will operate a service from Southampton to Buenos Aires.

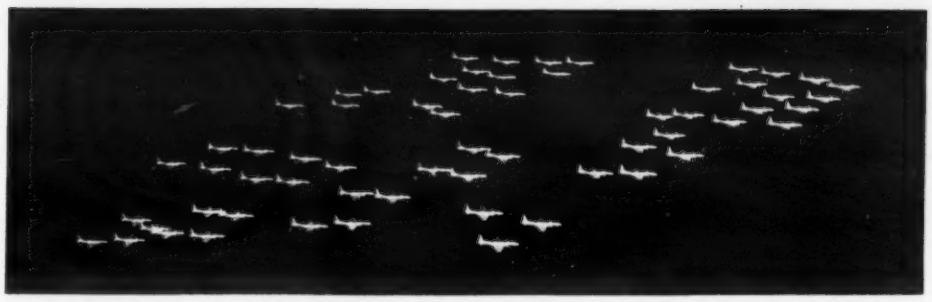
● *KLM* Royal Dutch Airlines announces that it will open its projected *service to China* in October, 1948. Lockheed "Constellations" will make one round flight weekly over the Amsterdam—Cairo—Basra—Karachi—Calcutta—Bangkok—Shanghai route.

● *Sabena* now offers sleeping berths on its Brussels—Leopoldville-Johannesburg service, flown with Douglas DC-6 aircraft. A surcharge of $50 is made.

● *Matters of civil aviation policy* were discussed by Australian Prime Minister Chifley with British Cabinet Ministers during his stay in London from July 7th to 14th. Subjects discussed included intensification of services between Britain and Australia, the purchase of additional aircraft for joint use by Qantas Empire Airways and BOAC, and the improvement of air services between Australia and Hong Kong in collaboration with BOAC.

● The Argentine Government has entrusted M. di Majo, an Italian expert in meteorological and flying control matters, to recruit experts and technicians in Italy to organise the meteorological and flying control services in Argentina.

● USA: A *sharp increase in U.S. aviation activity* by 1955 was prophesied on July 8th by Theodore P. Wright, former Civil Aeronautics Administrator and now Vice-President of Cornell University in charge of research. He believes that there will be 400,000 aircraft in service in 1955 (against 100,000 at the present time) by which time the number of pilots in the United States will have reached 1,000,000 (now 500,000). Scheduled air transport mileage would rise from 8,500,000,000 to 15,000,000,000 in the next seven years.



Sixty-two Lockheed "Shooting Star" jet fighters of the 36th Fighter Wing of the U.S. Air Force, training in the Caribbean area.

● *Trans World Airline intensified its domestic schedules* on July 1st, 1948, so as to provide 113 passenger flights daily, including 30 trans-continental flights from Boston, New York, Philadelphia, Washington, and Baltimore, on the East Coast, to Los Angeles and San Francisco on the West Coast.

● United Air Lines flew its 10,000,000th passenger on July 8th. The line has flown more than 5,000,000,000 passenger-miles since its predecessor companies started operations in 1926.

● *Braniff International Airways celebrated its 20th anniversary on June 20th.* The company has only had one accident in its history. Its fleet of 32 aircraft comprises Douglas DC-3, DC-4 and DC-6 airliners.

● The U.S. Civil Aeronautics Board has now officially recognised the change of name of Pennsylvania-Central Airlines Corp. to Capital Airlines, Inc.

● The Civil Aeronautics Board has carried out a *survey of commodities shipped by air freight.* Heading the list is womens' apparel with 30.6 per cent. of the total. Next comes perishable goods (fruit, vegetables, flowers) at 13.5 per cent., followed by durable goods; automobile parts and accessories, 7.1 per cent.; machinery and machine parts, 5.3 per cent.; electrical appliances and parts 4.5 per cent.

GROUND ORGANIZATION: The Air Transport Association of America has abandoned the idea of pooled ground services at airports served by its member airlines. Failure of the scheme is attributed to lack of cooperation amongst the participating airlines, particularly differences concerning the methods of operation. Moreover, the anticipated economies did not result.

● *The 1949 Federal-Aid Airport Programme lists 455 new projects and additions to existing projects* at an estimated cost to the Federal Government of over $35,000,000, with local or State sponsors providing an additional $38,700,000.

● Scheduled commercial operations at *New York International Airport*, Idlewild, started on July 8th when a Peruvian International Airways Douglas DC-4 arrived from Santiago-de-Chile.

SERVICE AVIATION

● The USAF 36th Wing, comprising 75 Lockheed "Shooting Star" jet fighters, is being transferred from the Panama Canal Zone to Germany. The U.S. Navy aircraft carrier "Sicily" left Colon on July 22nd with about 60 aircraft fully assembled on the flight deck and the remainder partly dismantled below. The deck aircraft will be flown off on arrival in the Clyde on August 1st, whilst the stowed machines will be assembled in Glasgow. The Wing will subsequently fly from Britain to Germany.

● *Six Royal Air Force* de Havilland "Vampire" jet fighters landed at Goose Bay, Labrador, on July 14th, thus *accomplishing the first trans-Atlantic formation flight by jet aircraft.* They flew via Stornaway (Hebrides), Keflavik (Iceland), and Bluie West (Greenland). On July 20th, 16 USAF Lockheed "Shooting Star" jet fighters landed at Stornaway after making the trans-Atlantic flight in the reverse direction. They had come from Selfridge Field, Mich., via Bangor (Maine), Labrador, Greenland and Iceland.

● Re-equipment of the USAF Air National Guard with Lockheed F-80C "Shooting Star" jet fighters has begun, following the assignment of 107 of these aircraft to the ANG. The re-equipment programme for the ANG aims at an eventual strength of 3,212 aircraft, 92 per cent. of which will be Lockheed F-80Cs and the balance North American B-45 jet bombers.

● The *U.S. Navy* is planning to recruit 2,000 aviation cadets in the 1949 fiscal year to June 30th, 1949. This is the first post-war recruiting programme launched by the Navy and is to be continued with "large yearly quotas." The *U.S. Air Force* flight training programme for the 1949 fiscal year calls for the recruitment of 3,000 cadets.

● The *Soviet Union celebrated its 1948 "Aviation Day"* on July 18th. On this occasion, Marshal Konstantin Vershinin, Commander-in-Chief of the Soviet Air Force, claimed that Russia had surpassed the West in the development of jet aircraft. General Vladimir Studets, Chief of Air Staff, stated that Russia built the first aircraft in the world in 1882 and the world's first multi-engined aircraft in 1913. "Pravda" wrote that Soviet leadership in the solution of all aeronautical problems was undisputed. The Air Show over Tushino airport was cancelled one hour before it was due to start, owing to bad weather.

● A Bill for an increase of pay in the Army, Navy and Air Force by a full 30 per cent. was signed by Argentine President Peron at the beginning of July. Officers above the rank of Lieutenant-Colonel now receive a higher rate of pay than their American counterparts.

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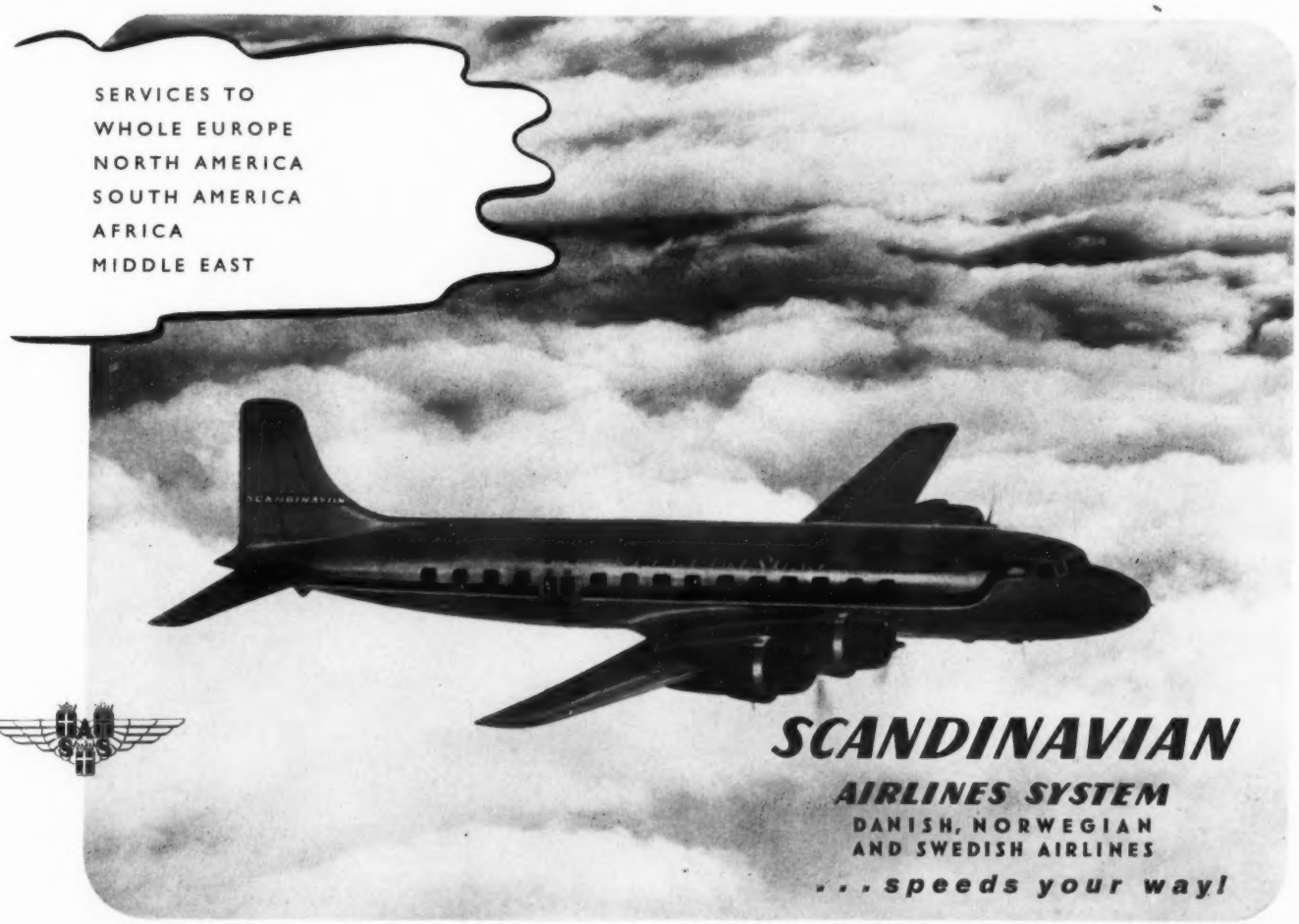

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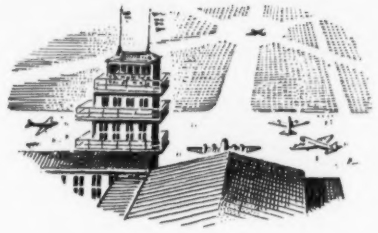

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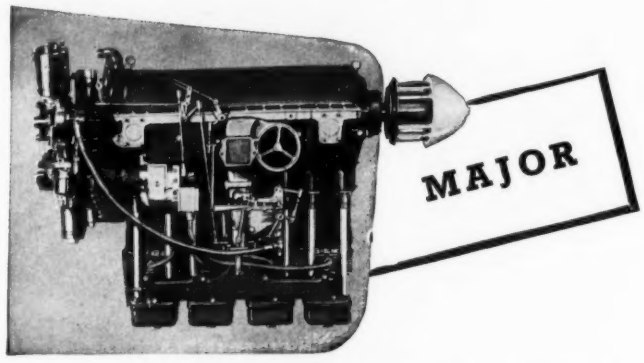

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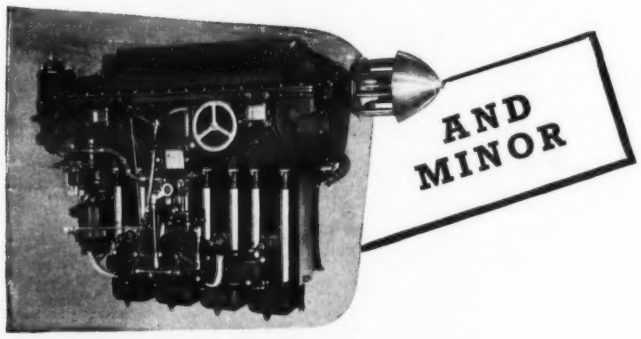

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